MACHINERY.

January, 1906.

TEN-THOUSAND HORSE POWER ROLLING-MILL ENGINE.

CHARLES R. KING.

On the continent of Europe the number of very large rolling-mill engines is small. The visitor to Krupp's Essen-Ruhr works finds there but a collection of old, out-of-date machines, and at the great steel works of Cockerill, which is built upon the site of its own coal mines, the largest reversing rolling-mill engine in use up to this year was of only 1,800 horse power. In less celebrated works, as for instance, the Diosgyor forges belonging to the Hungarian State Railroads, there are single-expansion reversing engines of 4,200 effective horse power, while in France the great works, at Creusot, have an engine of about 8,000 horse power for armor-plate rolling; and several other firms of less note in France have machines of English build indicating a yet higher power.

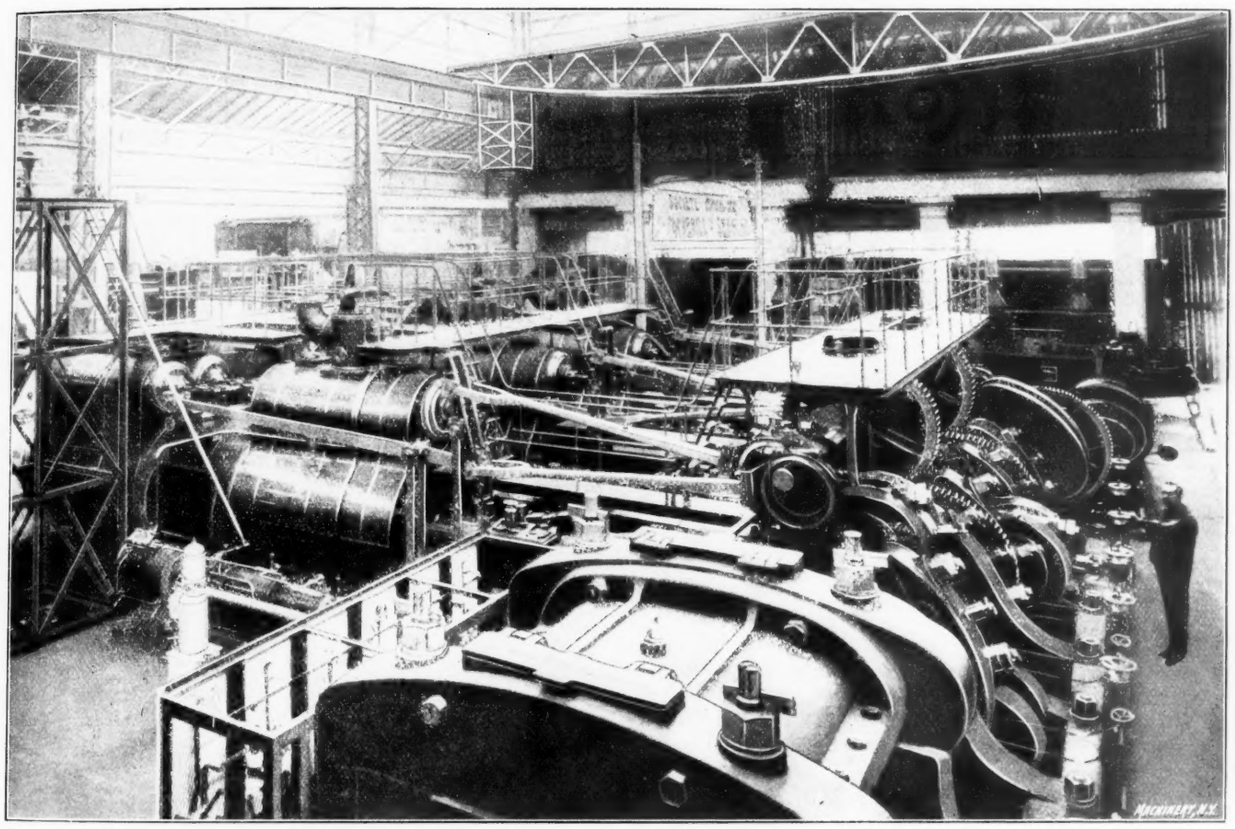

Fig. 1. The Cockerill Ten Thousand Horse Power Rolling Mill Engine.

An engine of about 8,000 effective horse power, or of 10,000 indicated horse power, at 120 revolutions, with an initial steam-pressure of 117½ pounds, has recently been built by the firm of John Cockerill at Seraing, near Liege, for operating its blooming and girder mills at Seraing in place of the small units hitherto employed.

This type of machine is novel, being a triple, tandem engine with six cylinders, having only three cranks, set at angles of 120 degrees. The steam distribution is effected by piston-valves throughout; that is, one piston valve for each high-pressure cylinder in front, and two valves, set side by side, for each low-pressure cylinder at the back of the machine. In this way all the piston valves are of the same diameter (13 inches) and, being identical, are perfectly interchangeable. By this arrangement, also, sufficient port areas have been provided without introducing inconveniently large valve chests. All three valve-spindles in each tandem group are actuated from rocker-shafts carried in bearings bolted on the casting which connects the front and back groups of cylinders, and each valve rod takes its motion from a link of the Allen type, as shown clearly in the view, Fig. 1.

The eccentric shaft is, it will be seen, driven by two pairs of spur wheels from the crankshaft. Reversing is effected from the horizontal steam assistant engine shown on the left-hand side, and at the base of the cylinder. From the high pulpit or staging erected on the left-hand side the engineer has a clear view of each set of valve gears, Fig. 1, placed, as they are, to the right of each pair of tandem cylinders. This elevation enables him to observe the operations on the rolling-mill floor. For the inspection of the engine a series of bridges and gang-ways is provided, giving access to all parts of the engine. Shaded incandescent lamps will illuminate all the working parts at night or in dull weather.

The throttle rod for opening the valve of the small assistant motor is visible in the photographic view. The piston of this motor acts upon an angle-crank (hidden from view in the engraving) in connection with the vertical rods and the link blocks—both visible. Another lever on the engineer's platform connects, by rod, to the throttle of a vertical assistant motor which is bolted to the front side of the steeple-shaped drop-seat valve chamber of the middle low-pressure cylinder; and this motor is connected through cranks and horizontal rods to the drop-seat admission-valves of the high-pressure cylinders, for starting the engine. The drop-seat main steam valves, in the outside casings of the high-pressure valve-chests are 10¼ inches diameter, and the steam pipes (disconnected in the view) are 10⅝ inches diameter. Differing in this respect, the drop-seat valves 17¼ inches diameter, of the low-pressure, are fitted in the piston-valve chests be-

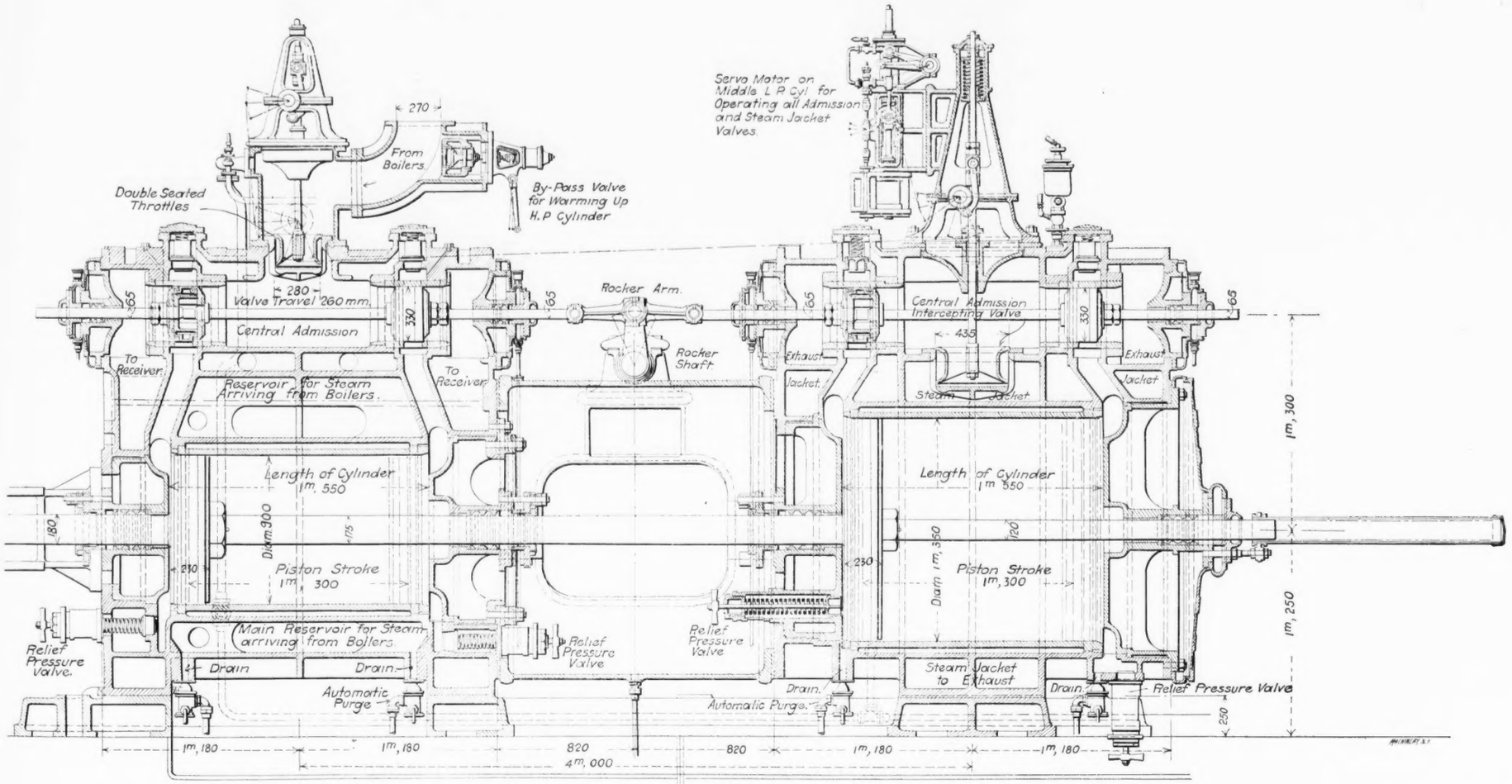

Fig. 2. Longitudinal Section through Cylinders and Valve Chests.

tween the latter and the cylinder, the object of the arrangement being to cut-off the steam from the steam-jackets of the low-pressure cylinders simultaneously with the closing of the drop-valves (throttles) on the high-pressure cylinders. Both the cylinders and the valve chests are steam jacketed, those of the high-pressure cylinders being opened to steam direct by means of the admission valve, while in the low-pressure cylinders it is the exhaust therefrom which warms the jackets. During or after prolonged stops there would be an excessive condensation in the voluminous jackets of the low-pressure cylinders, causing a drop in the pressure of the reservoirs, and so to obviate this the Société John Cockerill patented in 1882 the arrangement above described, which is automatic in action. To warm up the cylinders before starting, steam is admitted by means of a small valve and by special pipes to the high pressure jackets. The half-tone illustration was taken while the engine was on exhibition and the pipes are not shown fitted up, as the machine is simply run from a small electric motor to avoid the intolerable heat to visitors which would be caused by such a large machine in motion.

The usual reservoirs for the steam in most rolling engines are here constituted by the great capacity of the jackets combined with the length of the steam pipes from the boilers.

The exhaust (from the low pressure jackets) is directed through two pipes of 25½ inches diameter, one on each side of the middle low-pressure cylinder, and thence escaping to the air.

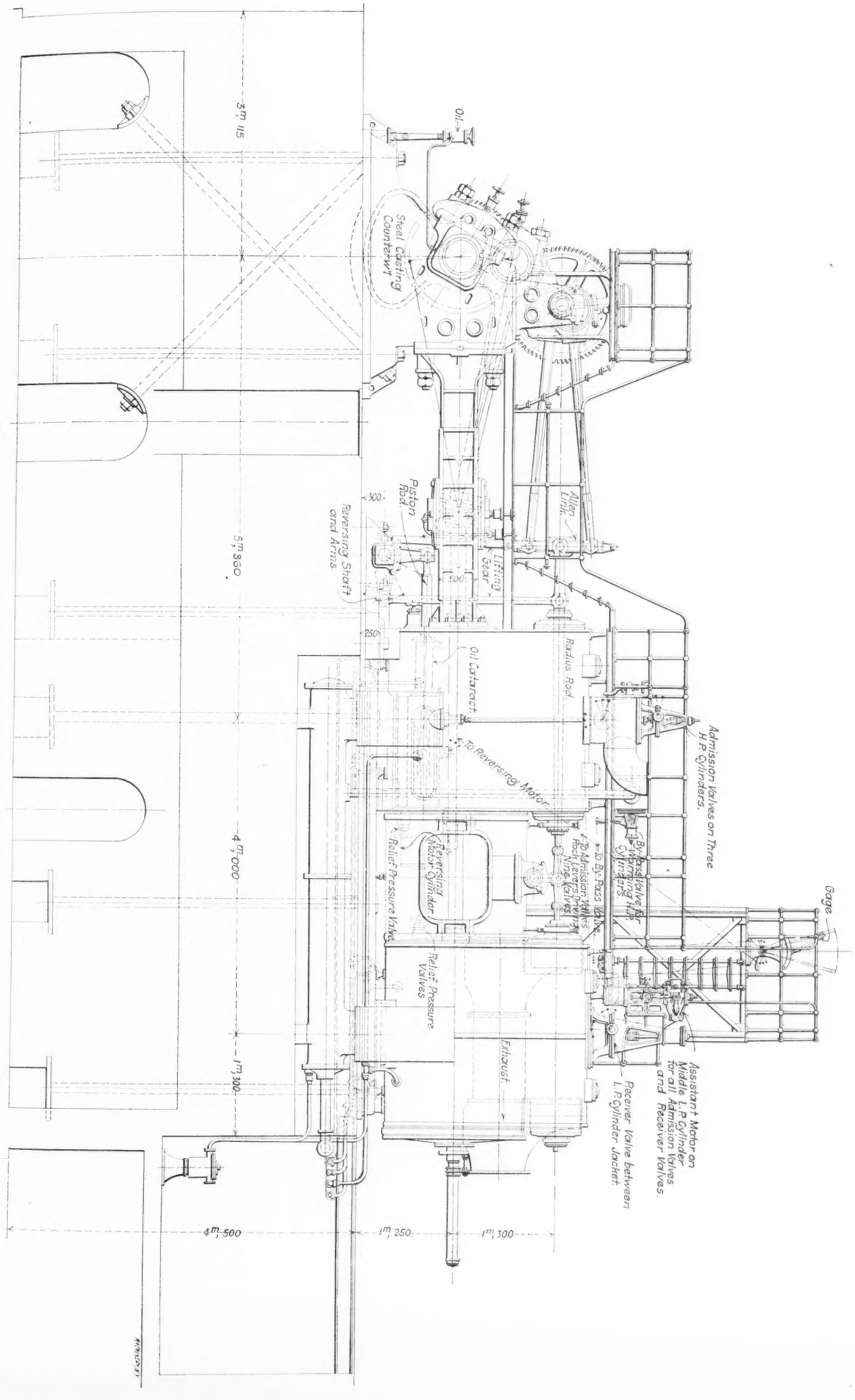

Fig. 3. Side Elevation of Ten-thousand Horse Power Rolling-mill Engine and its Foundations.

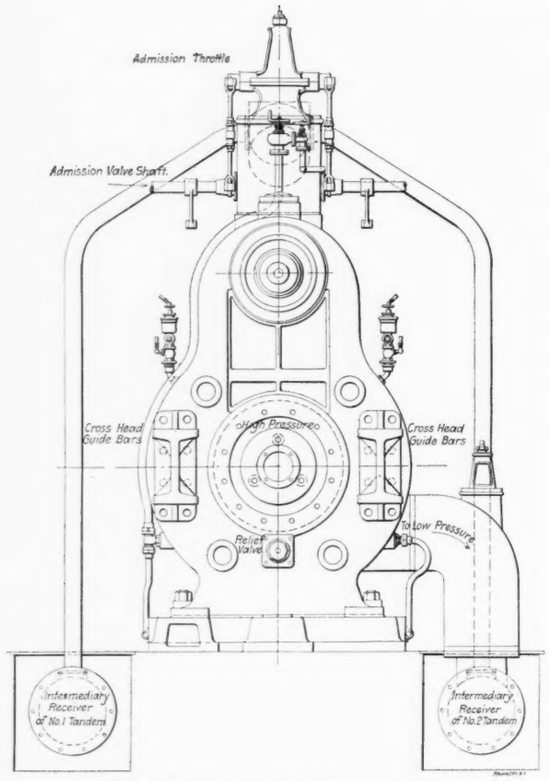

Fig. 4. End View of High Pressure Cylinder.

The cylinders are 35½ inches and 53¼ inches diameter and the piston stroke is 51 inches. Relief pressure valves are fitted to all the cylinder covers, the discharge going direct to the exhaust passages.

There is no bed-plate to the engine, the cylinders being anchored direct to the masonry foundations, as are also the thrust bracket of the crankshaft. The only connections between cylinders and crank-shaft pedestals are the ribbed I-section steel castings 19¾ inches in depth by 12 inches wide, two to each cylinder, which form the guide bars for the piston cross heads. These guide bars are spaced 55 inches between their center lines. The slippers of the piston cross-heads clasp the two edges of these beams. The main driving rods are relatively short, 10 feet, and the piston rods are 7⅛ inches diameter.

The crank-throws and the counter-weights are one-piece steel castings built up with forged steel pins of 17 inches diameter, which is the diameter, also, of the crank shaft.

The crankshaft pedestal bases are all solidly bolted together in a transverse line. The total width of this piece, which is the maximum width of the group of cylinders, is 17 feet 6 inches, the length of the engine is 43 feet, but the height from the floor to the top of the cylinder casing is only 9 feet 10 inches.

The sheathing plates or laggings are of polished "Russia" iron, which gives the machine a neat appearance.

The engine shaft connects with the mill shaft through gear wheels, the box containing which is conspicuous in the foreground of our illustration.

* * *

The effect of cutting a V-thread on a bolt is nearly the same as for a circumferential groove of the same form as the thread groove. It has been found by experimental investigations, says Prof. Jones in his book, "Machine Design, Part II.," that on account of the strengthening effect of the thread, with fairly good rubbing surfaces reasonably well lubricated, the

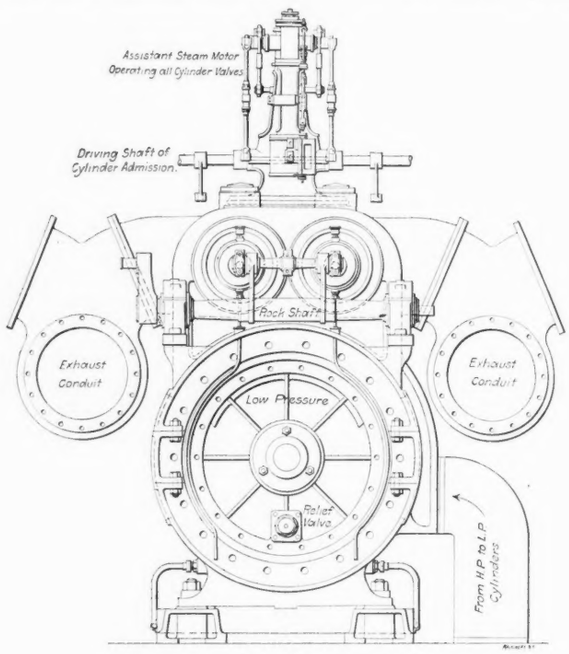

Fig. 5. End View of Low Pressure Cylinder.

axial tensile strength per square inch which will cause rupture in a U. S. standard screw bolt while tightening the nut, is practically the same as the breaking strength per square inch of the body of the bolt. This means that the twisting effect of the nut may be neglected.

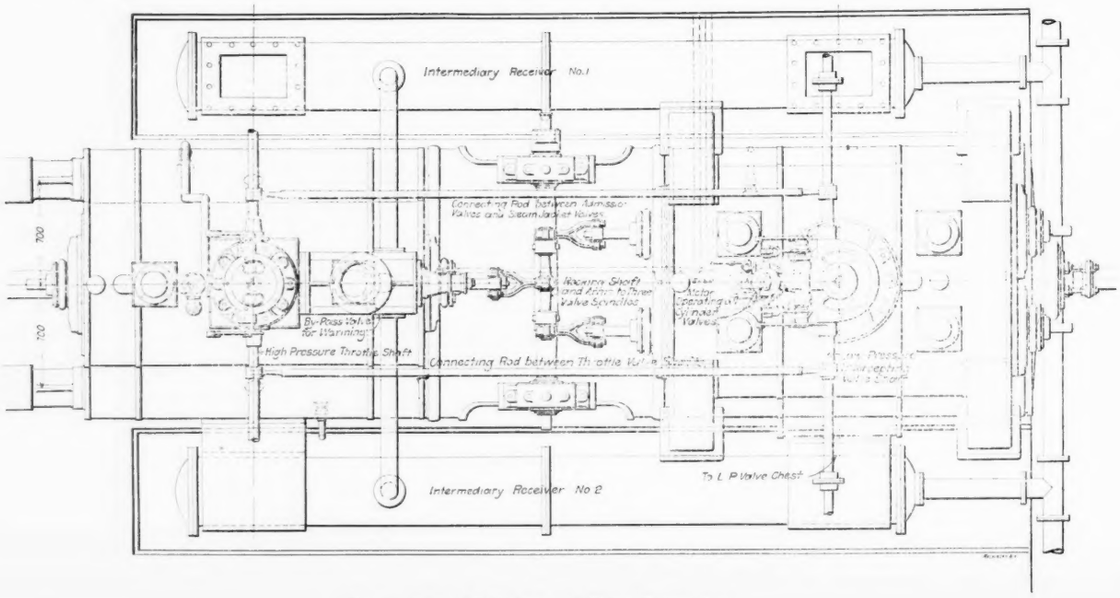
Intermediary Receiver No.1
Connecting Rod between Admission Valves and Steam Jacket Valves
By-Pass Valve for Warming
High Pressure Throttle Shaft
Connecting Rod between Throttle Valve and
To L.P. Valve Chest
Intermediary Receiver No.2

Fig. 6. Plan of Cylinders and Valve Connections.

THE CHOICE OF A FACTOR OF SAFETY FOR A MACHINE MEMBER.

FORREST E. CARDULLO.

It is the custom among most firms engaged in the designing of machinery to settle upon certain stresses* as proper for given materials in given classes of work. These stresses are chosen as the result of many years of experience on their own part, or of observation of the successful experience of others, and so long as the quality of the material remains unchanged, and the service does not vary in character, the method is eminently satisfactory.

Progress, however, brings up new service for which precedent is lacking, and materials of different qualities, either better or cheaper, for which the safe working stresses have not been determined, and the designer is compelled to determine the stress proper for the work in hand by using a so-called "factor of safety." The name "factor of safety" is misleading for several reasons. In the first place, it is not a factor at all, but is in its use a divisor, and in its derivation a product. In order to obtain the safe working stress, we divide the ultimate strength of the material by the proper "factor of safety," and in order to obtain this factor of safety we multiply together several factors which depend in turn upon the qualities of the material, and the conditions of service. So our factor of safety is both a product and a divisor, but it is not a factor. Then again, we infer, naturally, that with a factor of twelve, say, we could increase the load upon a machine member to twelve times its ordinary amount before rupture would occur, when, as a matter of fact, if the usual load were doubled the piece would very soon rupture. The margin of safety is apparent, not real, and I will therefore call the quantity we are dealing with the "apparent factor of safety, for the name factor is, I am sure, too firmly fixed in our minds for either my readers or myself to easily throw it off.

The apparent factor of safety, as has been intimated, is the product of four factors, which for the purpose of our discussion, I will designate as factors a, b, c and d. Factors b and c, as will appear later, may be, and often are 1, but none the less they must always be considered and given their proper values. Designating the apparent factor of safety by F, we have then

$$F = a \times b \times c \times d.$$

The first of these factors, a, is the ratio of the ultimate strength of the material to its elastic limit. By the elastic limit I do not mean the yield point, but the true elastic limit within which the material is, in so far as we can discover, perfectly elastic, and takes no permanent set. There are several reasons for keeping the working stress within this limit, the two most important being: First, that the material will rupture if strained repeatedly beyond this limit; and second, that the form and dimensions of the piece would be destroyed under the same circumstances. If a piece of wire be bent backward and forward in a vise, we all know that it will soon break. And no matter how little we bend it, provided only that we bend it sufficiently to prevent it from entirely recovering its straightness, it will still break if we continue the operation long enough. And similarly, if the axle of a car, the piston rod of an engine, or whatever piece we choose, be strained time after time beyond this limit of elasticity, no matter how little, it will inevitably break. Or suppose, as is the case with a boiler, that the load is only a steady and unremitting pressure. The yielding of the material will open up the seams, allowing leakage. It will throw the strains upon the shorter braces more than upon the others, thus rupturing them in detail, and I could go on to mention a dozen other disagreeable things that would result. It is absolutely necessary, therefore, excepting in very exceptional cases, that we limit our working stress to less than the elastic limit of the material.

Among French designers it is customary to deal entirely with the elastic limit of the material, instead of the ultimate strength, and with such a procedure no such factor as we have been discussing would ever appear in the makeup of our apparent factor of safety. Although this method is rational enough, it is not customary outside of France, because many of the materials we use, notably cast iron, and sometimes wrought iron and hard steels, have no definite elastic limit. In any case where the elastic limit is unknown or ill-defined, we arbitrarily assume it to be one-half the ultimate strength, and factor a becomes 2. For nickel-steel and oil-tempered forgings the elastic limit becomes two-thirds of the ultimate strength, or even more, and the factor is accordingly reduced to 1½.

The second factor, b, appearing in our equation is one depending upon the character of the stress produced within the material. The experiments of Wohlet, conducted by him between the years 1859 and 1870 at the instance of the Prussian government, on the effects of repeated stresses, confirmed a fact already well known, namely, that the repeated application of a load which would produce a stress less than the ultimate strength of a material would often rupture it. But they did more. They showed the exact relation between the variation of the load and the breaking strength of the material under that variation. The investigation was subsequently extended by Weyrauch to cover the entire possible range of variation. Out of the mass of experimental data so obtained a rather complicated formula was deduced, giving the relation between the variation of the load (or rather the stress it produced), the strength of the material under the given conditions (which is generally known as the "carrying strength" of the material) and the ultimate strength. To Prof. J. B. Johnson, I believe, is due the credit of substituting for this formula a much simpler and more manageable one, which perhaps represents the actual facts with almost equal accuracy. Prof. Johnson's formula is as follows:

$$f = \frac{U}{2 - \frac{p'}{p}}.$$

Where f is the "carrying strength" when the load varies repeatedly between a maximum value, p, and a minimum value, p', U is the ultimate strength of the material. The quantities p and p' have plus signs when they represent loads producing tension and minus signs when they represent loads producing compression.

From what I have just said, it follows that if the load is variable in character, factor b must have a value,

$$b = \frac{U}{f} = 2 - \frac{p'}{p}.$$

Let us now see what this factor will be for the ordinary variations in loading.

Taking first a steady, or dead load, $p' = p$ and therefore $\frac{p'}{p} = \frac{1}{1} = 1$, and we have our factor,

$$b = 2 - \frac{p'}{p} = 2 - 1 = 1.$$

In other words, this factor may be omitted for a dead load.

Taking a load varying between zero and a maximum,

* Throughout this article we will adhere to the following definitions:

A "stress" is a force acting within a material, resisting a deformation.

A "load" is a force applied to a body, from without. It tends to produce a deformation, and is resisted by the stress which it creates within the body.

A "working load" is the maximum load occurring under ordinary working conditions.

A "working stress" is the stress produced by the working load, statically applied.

The "safe working stress" is the maximum permissible working stress under the given conditions.

The "ultimate strength" of a material is its breaking strength in pounds per square inch, in tension, compression, or shearing, as the case may be.

A "total stress" is the sum of all the stresses existing at any section of a body.

Unless a stress is mentioned as a total stress, the number of pounds per square inch of section, sometimes called "the intensity of stress," will be meant.

FORREST E. CARDULLO was born in Buffalo, N. Y., 1879. After completing a high school course at Titusville, Pa., he attended Cornell University and received the degree of M. E. in 1901. He then served an apprenticeship with the Titusville Iron Co., and has since been employed by the Osborne Engineering Co., Cleveland, The Engineer Publishing Co., Chicago, The Holly Mfg. Co., Buffalo, and the Snow Steam Pump Works, also of Buffalo. His positions have been those of draughtsman, machinist, and designer, and he is now engaged in teaching the subject of Machine Design at Syracuse University, Syracuse. The class of work which he has specially devoted himself to is high-power steam and gas engines and heavy machine tools. He is known to the readers of mechanical literature by his contributions to the *Sibley Journal of Engineering* and *The Engineer*, and by his book on "The Principal Dimensions of Pumping Engines," which has come into use with pumping engine builders in preparing designs. The book has, as yet, been published and sold in blue print form only.

$$\frac{p'}{p} = \frac{0}{p} = 0,$$

and we have for our factor,

$$b = 2 - \frac{p'}{p} = 2 - 0 = 2.$$

Again, taking a load that produces alternately a tension and a compression equal in amount,

$$p' = -p \quad \text{and} \quad \frac{p'}{p} = -1,$$

and we have, for our factor,

$$b = 2 - \frac{p'}{p} = 2 - (-1) = 2 + 1 = 3.$$

A fourth time, taking a load which produces alternately a tension and a compression, the former being three times the latter,

$$p = -3p' \quad \text{and} \quad \frac{p'}{p} = -\tfrac{1}{3}.$$

and we have for our factor,

$$b = 2 - \frac{p'}{p} = 2 - (-\tfrac{1}{3} = 2 + \tfrac{1}{3} = 2\tfrac{1}{3},$$

Recapitulating our results, we may say that when the load is uniform, factor $b = 1$; when it varies between zero and a maximum, factor $b = 2$; when it varies between equal and opposite values, factor $b = 3$; when the load varies between two values, p and p', of which p' is the lesser factor, $b = 2 - \frac{p'}{p}$. It may be noted that this factor becomes 1 for such cases as a steam boiler, or a railroad bridge, where the load varies between zero and a maximum for only a few thousand times at the most. In the case of a piston rod, however, where the variation will be repeated for hundreds of millions of times, the factor must be given the full value noted in the first part of this paragraph, and so for any similar conditions of service.

The experiments which have been made upon the effects of variable loads have almost without exception been made upon mild steel and wrought iron. Designers are in need of data based upon the results obtained with bronze, nickel steel, cast iron, etc. The explanation of this matter is generally believed to be as follows:

It has already been noted that a stress many times repeated will rupture a piece when that stress is greater than the elastic limit, but less than the ultimate strength. It is also known that the application of a stress will change the elastic limit of a material, often by a very considerable amount. A material has really two elastic limits, an upper and a lower one, the latter often being negative in value (*i.e.*, an elastic limit in compression). Between these two limits there is a range of stress, which we may call the elastic range of the material, and within which the material is, so far as we can discover, perfectly elastic. It has been assumed, therefore, that under the influence of the varying or repeated load, this elastic range takes on certain limiting values depending on the character of the variation. So long as the variation is confined within these limits, the piece is safe. If, however, the range of variation of the stress, exceeds the elastic range of the material under the given conditions, the piece breaks down. In confirmation of this view of the case, it has been found that pieces long subject to alternating stresses have an elastic limit of one-third their ultimate strength, while pieces subject to either repeated tensions or compressions only, have an elastic limit of one-half their ultimate strength.

From lack of data we cannot speak with authority in this matter, but it is probable that for material whose elastic limit is other than one-half its ultimate strength, Prof. Johnson's formula, and considerations derived from it, no longer hold. It is more than likely that with fuller knowledge of the subject we will find that the facts of the case may be more truly expressed by the formula,

$$f = \frac{n\,U}{1 - \frac{p'}{p}(1 - n)}$$

where n is the ratio of the elastic limit to the ultimate strength.

The third factor, c, entering into our equation, depends upon the manner in which the load is applied to the piece. A load suddenly applied to a machine member produces twice the stress within that member that the same load would produce if gradually applied. When the load is gradually applied, the stress in the member gradually increases, until finally, when the full load is applied, the total stress in the member corresponds to this full load. When, however, the load is suddenly applied, the stress is at first zero, but very swiftly increases. Since both the load and the stress act through whatever slight distance the piece yields, the product of the average total stress into this distance must equal the product of the load into this same distance. In order that the average stress should equal the load, it is necessary that the maximum value of the stress should equal twice the load. In recognition of this fact, we introduce the factor $c = 2$ into our equation when the load is suddenly applied.

It sometimes occurs that not all of the load is applied suddenly, in which case the factor 2 is reduced accordingly. If one-half the load were suddenly applied, the factor would be properly 1½, and in general, if a certain fraction of the load, $\frac{n}{m}$, is suddenly applied, the factor is $1 + \frac{n}{m}$. Or again, it may occur that friction, or some specially introduced provision, may prevent the sudden application of the load from having its full effect, in which case, if the amount of the reduction of this effect be known, or if it be possible to compute it, an appropriate reduction may be made in the value of this factor.

Sometimes, however, a load is applied not only suddenly, but with impact. In such a case, it is highly desirable to compute the total stress produced by the load, and to substitute it for the load when obtaining the working section. Failing in this, it is necessary to make factor c more than 2, and sometimes as high as 10 or more. As an example of the possibilities arising in ordinary work, I may instance an elevator suspended by a wire rope of one square inch in section, and fifty feet long. If a truck weighing 500 pounds were wheeled over the threshold and allowed to drop two inches onto the elevator platform, a stress of over 10,000 pounds would be produced in the rope. Thus we see that in this very ordinary case arising in elevator service, this factor would need to be as much as 20.

The last factor, d, in our equation, we might call the "factor of ignorance." All the other factors have provided against known contingencies; this provides against the unknown. It commonly varies in value between 1½ and 3, although occasionally it becomes as great as 10. It provides against excessive or accidental overload, against unexpectedly severe service, against unreliable or imperfect materials, and against all unforeseen contingencies of manufacture or operation.

When we can compute the load exactly, when we know what kind of a load it will be, steady or variable, impulsive or gradual in its application, when we know that this load will not be likely to be increased, that our material is reliable, that failure will not result disastrously, or even that our piece for some reason must be small or light, this factor will be reduced to its lowest limit, 1½.

The conditions of service in some degree determine this factor. When a machine is to be placed in the hands of ignorant or unskilled labor, when it is to receive hard knocks or rough treatment, the factor must be made larger. When it will be profitable to overload a machine by increasing its work or its speed in such a way as to throw unusual strains upon it, we are obliged to discount the probability of this being done by increasing this factor. Or again, when life or property would be endangered by the failure of the piece we are designing, this factor must be made larger in recognition of the fact. Thus, while it is 1½ to 2 in most ordinary steel constructions, it is rarely less than 2½ for a better grade of steel in a boiler. Even if property were not in danger of destruction, and the failure of the piece would simply result in considerable loss in output or wages, as in the case of the stoppage of a factory, it is best to increase this factor somewhat.

The reliability of the material in a great measure deter-

mines the value of this factor. For instance, in all cases where it would be 1½ for mild steel, it is made 2 for cast iron. It will be larger in those materials subject to internal strains, for instance complicated castings, heavy forgings, hardened steel, and the like. It will be larger for those materials more easily injured by improper and unskillful handling, unless we know that the work will be done by skilled and careful workmen. It will be larger for those materials subject to hidden defects, such as internal flaws in forgings, spongy places in castings, etc. It will be smaller for ductile and larger for brittle materials. It will be smaller as we are sure that our piece has received uniform treatment, and as the tests we have give more uniform results and more accurate indications of the real strength and quality of the piece itself.

Of all these factors that we have been considering, the last one alone has an element of chance or judgment in it, except when we make an allowance for shock. In fixing it, the designer must depend on his judgment, guided by the general rules I have here attempted to lay down.

Some of my readers may ask at this point, why, if we introduce a factor for the elastic limit, do we also introduce a factor for repeated loads? They will argue that if we keep the stress within the elastic limit, no harm will be done, no matter how often the load be repeated, and they are right. However, with a dead load acting upon a piece and straining it to its elastic limit, we have as a margin of safety the difference between its elastic limit and its ultimate strength. But when the load is a repeated load, of the same amount as before, the piece has no margin of safety, unless its section be increased, and it does not have the same margin of safety as it had in the first place, until its section is doubled.

It remains to illustrate the method I have outlined for developing an "apparent factor of safety" by some practical examples. Let us take first the piston rod of a steam engine. It will be of forged steel, of simple form and reasonable size. The elastic limit will presumably be slightly more than one-half the ultimate strength, so factor $a=2$. The rod will be in alternate tension and compression many times a minute and factor $b=3$. The steam pressure will be applied suddenly (in a great many engines, on account of compression, only a part of this load is applied suddenly) and factor $c=2$. And since the material is reliable, and the service definite and not excessively severe, factor $d=1\frac{1}{2}$. Then,

$$F=2\times 3\times 2\times 1\frac{1}{2}=18.$$

Taking next a steam boiler, our factor $a=2$ as before. Since the load is steady and gradually applied, factor $b=1$ and factor $c=1$. Although we have an exceptionally reliable material, corrosion is likely to occur, and failure would be disastrous to life and property, so factor $d=2\frac{1}{2}$ or 3, depending upon the workmanship.

Then $F=2\times 1\times 1\times 2\frac{1}{2}$ (or 3) $=5$ (or 6).

For our last illustration we will take the rim of a castiron flywheel for a steam engine. Factor $a=2$, factor $b=1$, and factor $c=1$, for the load which is due to centrifugal force is constant. However, the material is the most unreliable with which the designer has to deal. It is probably spongy, and has great internal stress resulting from the cooling. It would be easy and profitable to increase both the power of the engine and the strain in the rim, by speeding it up. In ordinary cases we would make factor d equal to 3 or 4, but in this case the stress in the rim increases, not with the speed, but with the square of the speed, and it is entirely proper to make factor $d=10$. So we have

$$F=2\times 1\times 1\times 10=20.$$

The following table may be helpful in assisting the designer to a proper choice of the factor of safety. It shows the value of the four factors for various materials and conditions of service, and will give helpful hints to the young designers as to what factors to use under similar circumstances.

Class of Service or Materials.	Factor a	b	c	d	F
Boilers	2	1	1	2¼-3	4½- 6
Piston and connecting rods for double-acting engines..	1½-2	3	2	1½	13½-18
Piston and connecting rod for single-acting engines..	1½-2	2	2	1½	9 -12
Shaft carrying bandwheel, flywheel, or armature.....	1½-2	3	1	1½	6¾- 9
Lathe spindles	2	2	2	1½	12
Mill shafting	2	3	2	2	24
Steel work in buildings	2	1	1	2	4
Steel work in bridges.....	2	1	1	2½	5
Steel work for small work...	2	1	2	1½	6
Cast iron wheel rims.....	2	1	1	10	20
Steel wheel rims.....	2	1	1	4	8
Materials.	Minimum Values.				
Cast iron and other castings.	2	1	1	2	4
Wrought iron or mild steel..	2	1	1	1½	3
Oil tempered or nickel steel.	1½	1	1	1½	2¼
Hardened steel	1½	1	1	2	3
Bronze and brass, rolled or forged	2	1	1	1½	3

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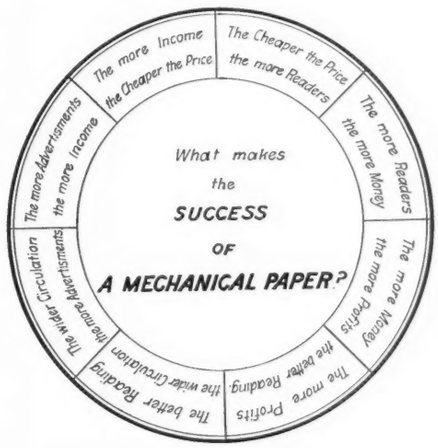
A JOURNALISTIC ROUND ROBIN.

An occasional correspondent, Mr. Edward W. Chodzko, of Haiphong-Tonkin, China, has been making a long distance telescopic study of the trade paper problem and has sent us a sketch embodying the conclusions derived from his investigations. We are not sure that the cut has been made right side


What makes the SUCCESS OF A MECHANICAL PAPER?
The more Income the Cheaper the Price
The Cheaper the Price the more Readers
The more Readers the more Money
The more Money the more Profits
The more Profits the better Reading
The better Reading the wider Circulation
The wider Circulation the more Advertisments
The more Advertisments the more Income

up, as a prolonged contemplation of the copy induces a feeling of dizziness, rendering it inadvisable to investigate the matter too closely. The idea which underlies the diagram is very evident, and on the whole it is a good way of expressing the relation of the various factors which influence the development of a growing technical journal.

* * *

FRICTION GEARING.

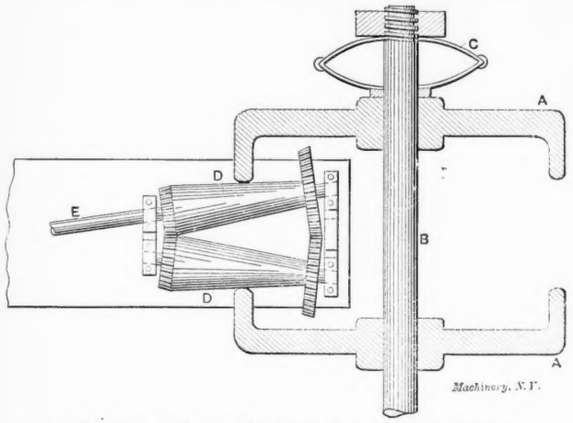
Perhaps there is no form of power transmission at which designers look askance more than the so-called friction wheel gearing, and the disfavor with which it is viewed is apparently well merited in view of the inefficiency of most forms of friction wheel drive. But there are two sides to the question and when we look at it broadly it becomes evident that the usual defect of the friction drive, slipping, is not essentially fundamental. For example, we have but to look at the locomotive, which is the most common example of power transmission by the mere friction of smooth surfaces, *i. e.*, the drivers and track. The efficiency of the locomotive as a friction wheel power transmitter lies largely in the fact that the coefficient is chosen well within the limits which mark average working conditions. The extreme coefficient is usually taken at 24 or 25 per cent. That is, the drivers will give a tractive power equal to about one-fourth the weight they carry before they begin to slip. For example, if the weight carried by four drivers is 80,000 pounds the maximum tractive force can be figured as being about 20,000 pounds. This figure, however, is too high with certain conditions of rail, hence the sandbox as a corrective. If now, a friction drive of the stationary type is so designed that the power transmission required comes within a coefficient limit, say, of 10 or 12 per cent, it is quite plain that such a drive must always operate, provided that constant pressure is maintained between the driving and driven wheels sufficient to balance the required torque with the friction coefficient named. The reason that it must always drive without slipping is that the coefficient of 10 or 12 per cent is less than that of poorly lubricated surfaces, and should

TABLE SHOWING NUMBER OF PIECES IN ONE POUND WHEN WEIGHT OF ONE HUNDRED PIECES IS GIVEN.

Pounds. ☞	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Oz.	100.00	50.00	33.33	25.00	20.00	16.67	14.29	12.50	11.11	10.00	9.09	8.33	7.69	7.14	6.66	6.25	5.88	5.56	5.26	5.00	4.76	4.54	4.35	4.16	4.00
1	1600.00	94.12	48.48	32.65	24.61	19.75	16.49	14.16	12.40	11.03	9.94	9.04	8.29	7.65	7.11	6.64	6.23	5.86	5.54	5.24	4.98	4.74	4.53	4.34	4.15	3.99
2	800.00	88.88	47.06	32 00	24 24	19.51	16.33	14.03	12.31	10.96	9.88	8.99	8.25	7.62	7.08	6 61	6 20	5.84	5.52	5.23	4.96	4.73	4.52	4.33	4.14	3.98
3	533.33	84.21	45.71	31.37	23.88	19.27	16.16	13.91	12 21	10.89	9.82	8.94	8.20	7.58	7.04	6.59	6.17	5.82	5.50	5.21	4.95	4.71	4.51	4.32	4.13	3.97
4	400.00	80.00	44.44	30.77	23.52	19.05	16.00	13.79	12.12	10.81	9.76	8.89	8.16	7.54	7.01	6 56	6.15	5.80	5.48	5.19	4.94	4.70	4.50	4.30	4.12	3.96
5	320.00	76.19	43.24	30.19	23 19	18.82	15.84	13.67	12.03	10.74	9.69	8.84	8.12	7.51	6.98	6.53	6.13	5.78	5.46	5.18	4.92	4.69	4.49	4.29	4.11	3.95
6	266.66	72.73	42.11	29.63	22 86	18.60	15.69	13.56	11.94	10.67	9.64	8.79	8.08	7.47	6.95	6.50	6.11	5.76	5.44	5.16	4.90	4.68	4.48	4.28	4.10	3.94
7	228.57	69.57	41.03	29 09	22.53	18.39	15 53	13.44	11.85	10 59	9.58	8.74	8.04	7.44	6 92	6.47	6.08	5.74	5.42	5.14	4.89	4.66	4.46	4.27	4.09	3.93
8	200.00	66.67	40 00	28.57	22.22	18.18	15.38	13 33	11.76	10.53	9.52	8.69	8.00	7.41	6 89	6.45	6.06	5.72	5.40	5.12	4.88	4.65	4.44	4.25	4.08	3.92
9	177.78	64.00	39.02	28.07	21.92	17.98	15.24	13.22	11.68	10.46	9.47	8.65	7.96	7.37	6.86	6.43	6.04	5.70	5.38	5.11	4.86	4.64	4.43	4.24	4.07	3.91
10	160.00	61.54	38.09	27.58	21.62	17 78	15.09	13.11	11.59	10.39	9.41	8.60	7.92	7.34	6.84	6.40	6.01	5.68	5.36	5.09	4.84	4.63	4.42	4.23	4.06	3.90
11	145.45	59.26	37 21	27.12	21.33	17.58	14.95	13.01	11.51	10.32	9.36	8.56	7.88	7.31	6.81	6.37	5.98	5.66	5.34	5.08	4.83	4.61	4.41	4.22	4.05	3.89
12	133.33	57.14	36.36	26.67	21.05	17.39	14.81	12.90	11.43	10.25	9 30	8.51	7.84	7.27	6.78	6.35	5.96	5.64	5.32	5.07	4.82	4.60	4.39	4.21	4.04	3.88
13	123.08	55.17	35.56	26.23	20.78	17.20	14.68	12.80	11.35	10.19	9 25	8.46	7.80	7.24	6.75	6.32	5.94	5.62	5.31	5.05	4.81	4.59	4.38	4.19	4.03	3.87
14	114.29	53.33	34.78	25.81	20.51	17.02	14.54	12.70	11.27	10.13	9.19	8.42	7.76	7.21	6.72	6.30	5.92	5.60	5.30	5.04	4.79	4.57	4.37	4.18	4.02	3 86
15	106.67	51.61	34.04	25.40	20.25	16.84	14.41	12.60	11.19	10.06	9.14	8.38	7.73	7.17	6.69	6.27	5.90	5.58	5.28	5.02	4.78	4.56	4.36	4.17	4.01	3.85

the working surfaces become greasy they must still continue to transmit power, nevertheless.

The difficulty with this proposition lies in the fact that with the usual design a large percentage of the power transmitted



An Example of Friction Gearing without Frictional Reaction.

is absorbed in journal friction. For example, suppose that we have two friction wheels 20 inches in diameter. They are required to transmit a torque of 100 pounds measured at the periphery. With the coefficient of 10 per cent this means that the wheels must be held together with a force of at least 1,000 pounds. This pressure of 1,000 pounds reacts upon the journals and if the journals are say 2 inches in diameter it means that practically one-fifth or 20 per cent of the power transmitted will be absorbed in journal friction under average conditions. This is very objectionable, not only because of a loss of power, but because of the trouble due to journal heating which is almost sure to result when any large amount of power is to be transmitted. But if the designer bears in mind the fact that the force required to produce traction may be balanced and in that way he can relieve the bearings of unnecessary load, a long step is taken in advance. To illustrate the idea, we present herewith a cut taken from a specification of a patent granted to Mr. A. Robinson in 1889, No. 406,477. The principle shown is so evident that little explanation is necessary. The shaft *B* carries two disks, *A A*, one of which is tightly secured to the shaft, and the other is loosely keyed thereon so that the spring *C* is free to move it longitudinally. Between these disks are the friction rollers *D D* to which motion is transmitted. The two friction rollers carry the load due to the pressure of the spring *C* but that pressure is not transmitted to the journals of *D D*, being instead carried by surfaces in rolling contact. Hence, there is a total absence of excessive journal pressure and all the pressure produced by the spring *C* is absorbed in producing adhesion between disks *A A* and the rollers *D D*. This device is also a variable speed mechanism and one which apparently is meritorious.

* * *

TABLE SHOWING NUMBER OF PIECES IN ONE POUND WHEN WEIGHT OF ONE HUNDRED PIECES IS GIVEN.

The accompanying table shows the number of pieces in one pound when the weight of 100 pieces is known. It should be convenient oftentimes, especially in the stock-room when inventory is being taken. To illustrate its use find, for example, the number of pieces in one pound when 100 pieces weigh 5 pounds 9 ounces: The number in one pound is found by starting at "9" in the column headed "oz" and tracing to the right until underneath "5," where the number of pieces in one pound is found to be 17.98. The table was compiled by Mr. A. L. Kline, Chicago, Ill.

* * *

THE JANUARY DATA SHEET.

The material for this month's data sheet was contributed by Mr. R. F. Kiefer, of Sharon, Pa. Diagrams and tables are given to facilitate the computation of stresses in the members of the usual forms of roof trusses.

AN EXPERIMENT IN INDUSTRIAL EDUCATION.

O. M. BECKER.

As an illustration of the practical workings of factory education it may be worth while to describe the educational activities at a typical American industrial plant, the McCormick Works of the International Harvester Company, Chicago. The educational system in this factory, except the so-called "kindergarten" for apprentices, is very recent and by no means fully developed as yet. Indeed it is quite evident that the problem is yet scarcely touched.

The two forms of factory education, the one designed to develop technical skill and the other to raise the social and intellectual level of the employed, are carried on together. For a number of years it has been the practice to select from among the boys throughout the plant the most promising, and to place these in one of the tool room departments, the foreman of which was expected to give them somewhat more than the usual amount of supervision, and some instruction. The wages paid boys in his "kindergarten," as it has come to be called throughout the plant, are less than most of them are able to earn at piecework. There is, nevertheless, always a full quota in this class, and usually a number of boys on the waiting list. There is no apprenticeship contract, and indeed no systematic effort to give instruction, other than that which the boys get incidentally. It is, in fact, merely the old apprenticeship system, with the indentures omitted. No particular time is fixed during which the apprentices continue as such. They work along, most of them receiving increases in pay from year to year, and in course of time find themselves working among the older machinists and receiving average machinist's pay. The arrangement works very well, but like the old apprenticeship system, is wasteful of the apprentice's time, and therefore economically inefficient.

Fig. 1. The McCormick Technical School.

About two years since classes were formed in mechanical drawing, which were open to all employees, and which the "kindergartners" were encouraged to attend. There was an immediate response to the invitation, and very soon additional classes were opened. At first the classes met two evenings a week in rooms used for other purposes during the day. A small charge was made, not with the idea of covering the expense of the class, but rather to promote a feeling of independence in the students. They were not getting something for nothing, but like honest and independent men were paying the price for it.

The origin of these classes is itself interesting, and suggestive as a study in evolution. For some time a social settlement near the works had been encouraging the formation of various classes of neighborhood boys, and among others one for instruction in mechanical drawing was started. The instructor happened to be the chief draftsman at the McCormick Works, and the students were mainly employees in the same place. The classes increased in size and number, and came to the notice of the company officials through a contribution of suitable drawing tables which they made to the settlement. The officials became interested in the classes, and some time afterward approved the opening of similar ones in connection with the works.

So much interest was taken in mechanical drawing that classes in other subjects also were organized, on the same conditions; namely, evening meetings and a nominal fee, but open to everybody. All these were well patronized, not only by employees of the company, but by others in the neighborhood—some students even coming from remote parts of the city.

The educational scheme, as pointed out, was not thoroughly organized at this time, the purpose being not to start out with a full-fledged educational system, but rather to allow one to develop along lines of least resistance, adjusting itself to the needs and wants of its constituency as they became apparent. Under the superintendence of a thoroughly trained school man, experienced in administration, technical teaching, and for several years in close touch with the industrial situation through his employment in a large factory, the educational activities were planned without especial reference to their logical correlation, but rather with a view to encouraging employees of differing tastes and needs to become interested. The technical school offers to open a class in any subject in which a reasonable number, say five, will enroll and pay the fee, usually two dollars for a term of ten weeks or forty hours. In a few courses the fee is only one dollar a term.

Under this arrangement classes are maintained in Arithmetic (three), Domestic Science, English (two), Machine Demonstration, Machinery, Mechanical Drawing (three), Sewing, Shorthand and Typewriting, Penmanship and Manual Training or Woodwork. The number of students in each varies from five to more than a hundred. Some of the classes beginning work last fall continued throughout the three terms of the year to follow progressive courses in their respective subjects. In fact all but one or two did so last season. For each subject a course covering at least three terms of ten weeks (forty hours) each is mapped out. Some of the courses, as Mechanical Drawing and Machinery, for instance, cover

longer periods. The interest in the educational work is strikingly manifested by the large registrations and continued attendance, as well as the wide diversity in age and attainment of students. A majority of these are naturally young men and boys, a few as young as thirteen. There is, however, a liberal sprinkling of men, occasionally one past the half century mark.

The courses mapped out are intended to be intensely practical, those in the technical subjects especially being planned with the needs and experiences of the mercantile shop always in mind. For instance, in the drafting classes, the students learn to draw almost from the beginning the things with which they are familiar in the shops, and learn the practical methods of the big drafting room. In the machinery class, carried on in one of the large tool rooms of the plant, they turn out commercial work, such as is done on the same machines during the day by the machinists employed there. Furthermore, the instructors (each of the drawing classes has one, and the machinery class has two) are men who are themselves employed in the plant and thoroughly familiar with shop methods and practices. This alone would not suffice to make the instruction of a high order. But the men selected for leading the classes are also skillful and imbued with the teaching spirit.

The Machine Demonstration class deserves special mention, for so far as is known to the writer it is unique in purpose and method. A few concerns undertake to teach salesmen and repairmen the nature and structure of the machines they deal in. The class mentioned is open to all employees, but is designed especially for office men who constantly talk about and deal in machines and parts with which they are wholly unfamiliar except as to the name or designation. The man in charge of the class, a man who knows more about all the machines manufactured in the plant than anybody else does about any one of them, illustrates his lectures with the machines and parts themselves, erecting and dissecting them before, or rather in the midst of his class. The clerk who daily handles K451 in his reports comes to have a greater interest in his work because he realizes the significance of the piece as part of useful whole, as a result of his attendance upon the lectures.

The courses in English and other non-technical subjects are not directly correlated with the technical subjects. The drawing, machinery, and certain mathematics, are related, and students in one course are encouraged to take, and many do take, one or more of the others. The idea is to give in about two years time a course in machinery, drawing and mathematics that will be a pretty good substitute for the usual apprenticeship, particularly when supplemented by practice in the shops, as it usually is. One of the English classes is especially interesting. It is composed mainly of foreign speaking men who at the beginning of the course are able to speak little if any English. To bring this class to the attention of as great a number as possible of the employees who might be benefited by it, a circular letter calling attention to it, written in the simplest possible English without being childish, is from time to time given out in selected departments. The response is reasonably satisfactory.

Since many girls are employed about the works, it is the desire to make some provision for them also in the technical school courses. Classes in Cookery and Housekeeping, and in Sewing are well patronized. Heretofore the first-named class has been using one of the kitchens connected with the works' dining room as a class room; and the other has been meeting in one of the Rest Rooms for Girls. Next fall, when the classes reopen they will meet in "The Cottage," a typical workingman's cottage fitted up simply but tastefully as a sort of neighborhood house for the women. It will doubtless also be used for other classes of women and children, should there be occasion to organize such.

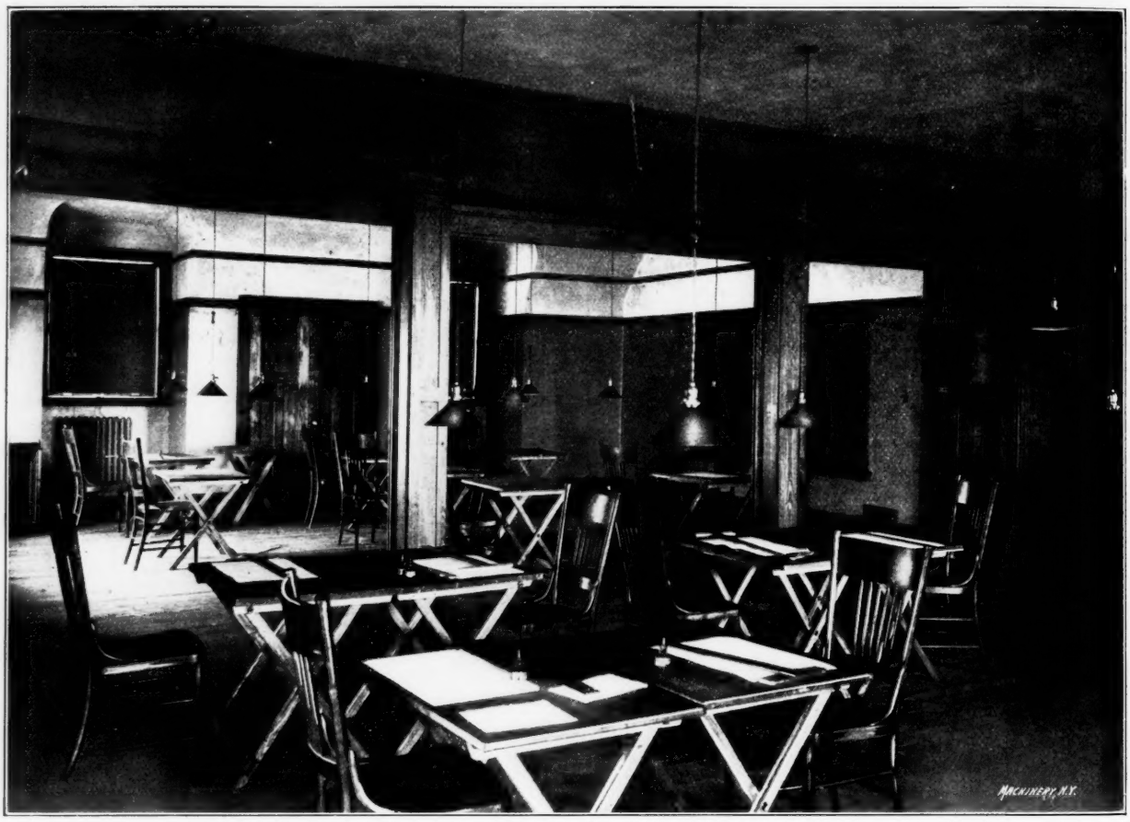


Fig. 2. Class Room for Instruction in Mechanical Drawing.

The men's and boys' classes have been meeting, since its completion, in the new club house near the plant, a building designed in part for this purpose. The class rooms are all that could be desired, but are equipped and fitted in such a way as to suppress as much as possible the usual schoolroom air. The library and reading room in this building is a valuable adjunct to the school activities.

The instructors in the Technical School are largely men employed in the works, and are selected because of their special knowledge in their respective subjects and skill in presenting them. They are on this account probably better fitted for their work than the teachers in most engineering, techni-

cal, or industrial schools, who usually have little or no practical shop experience and are, therefore, unacquainted with the actual conditions under which commercial work must be done. Some of the instructors in the school, however, are professional teachers or specialists employed elsewhere during the day. All are paid for their services.

A feature that is only indirectly educational is in connection with the use of the Chicago Public Library. Arrangements have been made so that any employee can take books, his library card being guaranteed by the company. The books are delivered to the workman's bench, and he is relieved of practically all care in taking and returning books further than to make selections of numbers from the finding lists and catalogues. This, however, is no small task for those of small acquaintance with book titles, and selections frequently turn out to be anything but pleasing. To help matters somewhat a number of lists of titles carefully selected as representative of the interests of young people and at the same time worthy of lasting place in literature have been printed and are at intervals distributed in such a way that a new list goes out each time to each reader, without great embarrassment to the library. The result has been unexpectedly satisfactory. There is much more reading than formerly, and in the main the reading is of a higher order.

No account of the educational activities at the McCormick works would be complete without a mention of how they began. For several years certain officials of the company had been greatly interesed in the problem of factory education, and had a number of times proposed to make a beginning in this direction. Finally, some two years ago, the new factory law came into effect, limiting to eight hours the labor of children between the ages of fourteen and sixteen. There were at the time a few, possibly fifteen, boys employed that were affected. Authority was given to organize these into a class, to meet during the first two hours of the day, under the instruction of an employee that had been a successful teacher. No particular course was marked out, the boys varying in attainment from graduates of the elementary school to those without any schooling. The general plan was to give as much individual instruction as possible in those things each boy seemed most deficient in. There were exercises in speaking and writing English, and much drill in arithmetic, nearly all of it developed with reference to the daily work and lives of the pupils. Occasionally, also, there were talks, by foremen and others, upon subjects in which especial interest had been manifested. One of the most interesting was a series of talks descriptive of his travels by a shop hand who had been about the world a good deal.

For one reason and another, chiefly because of no other boys of the limited age being employed and those in the class gradually leaving the employment of the company or passing the sixteen-year mark, the number was considerably reduced, and finally the class was closed, temporarily, as it was thought. The purpose, approved by the company officials, was to extend the little school gradually so as to take in all boys in the factory who cared to avail themselves of the privilege, allowing them certain hours weekly on company time for that purpose. A change in administration for the time being put the project in the background, and the need for it has been in part obviated by the more recent development of the McCormick Technical School. The logical evolution of the latter will doubtless again bring to the front the problem of getting at the boy who does not realize strongly his need for intellectual or technical training, and who with such training would become a much more efficient worker and better citizen. There is no reason to suppose that at the proper time the company will not again stand ready to extend the educational scheme to include just such instruction, on company time, as will make it possible to interest that class of boys, the boys who need most to be interested.

Though manifestly imperfect and inadequate as yet to the solution of the problem, the McCormick Technical School is nevertheless interesting as a successful experiment as far as it goes. It may point out, perhaps, the directions in which we may expect factory education to develop, for some time to come at any rate.

REPRESENTATIVE AMERICAN MECHANICS.

AMOS WHITNEY.

Amos Whitney was born in Biddeford, Maine, October 8, 1832. He served an apprenticeship with the Essex Machine Co., of Lawrence, Mass., beginning work at the age of 13. During his apprenticeship period of three years he worked on machinists' tools and locomotives, and after completing his apprenticeship, he stayed with the concern one year longer as a journeyman, working on cotton machinery. From Lawrence he went to Hartford, Conn., in 1850, to work in Colt's Armory. In 1852, F. A. Pratt came to Colt's, and there the future partners first became acquainted. In 1854 Mr. Pratt became superintendent for Geo. S. Lincoln & Co., afterwards known as the Phœnix Iron Works. Mr. Whitney went with him, and in 1860 he and Mr. Pratt started a little shop on Potter Street

Amos Whitney.

for making spoolers, both partners retaining their positions, working nights in their own shop. In 1862 Monroe Stannard, of New Britain, was taken into partnership, each partner putting into the business a capital of $1,200. This relationship continued until 1864, Mr. Pratt retaining his position as superintendent of the Phœnix Iron Works, and Mr. Whitney working there as a contractor. Incidentally it might be mentioned that it was while with this concern that Mr. Pratt designed the famous Lincoln miller. In 1864 both partners withdrew from the Phœnix Iron Works and gave all their time and attention to their own venture, building the first shop on the present location in 1865. From that time on, the history of Mr. Whitney is identified with that of the Pratt & Whitney Co., up to the time the business was sold to the Niles-Bement-Pond Co. in 1902.

From the beginning Pratt & Whitney machinery and tools were noted for fine quality and efficiency and within a few years they gained a world-wide reputation. Mr. Whitney is still (at the age of 73) a remarkably energetic man and possesses great endurance. For many years he was the principal salesman and also superintendent of the shops, sometimes having in his employ nearly 1,200 men. His ability to sell machinery and tools was not less marked than of keeping track of the work in the shop while away. On his return from business trips varying from two to eight weeks he would seem to know just how machinery being built on orders should have progressed, and could take up the broken thread as if he had been continuously in the shop.

For a period of 30 years he traveled about one-third of the time, visiting factories large and small throughout the principal manufacturing districts of the United States. His acquaintance was very large with the owners and their superintendents and foremen, and he enjoyed an enviable reputationtion for good judgment and reliability with them. He was often called upon to give advice with regard to machinery

for increasing product and reducing costs and many orders resulted which were of great benefit to the customers. In some cases he was given *carte blanche* to go ahead and build new machinery for a plant on his own responsibility, and with such orders he took great care to handle the work to the advantage of the purchaser. This popularity with large concerns had its drawbacks, for it led to the building of a great variety of machinery, much of which was of a special nature, on which no direct profit was made, as the cost often exceeded the figure which Mr. Whitney believed the customer could appreciate.

It was always Mr. Whitney's policy to keep close to the workmen, and visiting mechanics who desired the privilege of going through the shop were rarely denied. In fact, he often gave his own time in showing them about, and explaining machinery and methods of manufacture. Needless to say, this was missionary work of the most valuable kind, for in after years some of these men came to have positions of responsibility, and the methods they saw used in the manufacture of Pratt & Whitney machines, naturally inclined them to purchase from that concern when they wanted a first-class product.

In 1871 and 1872, after the close of the Franco-Prussian war, the Pratt & Whitney Co. received from the German government orders for gun machinery to equip three royal armories amounting to $1,450,000. Another work which gave the concern great prestige was the development of the standard plugs and gages, and this was brought about largely by the confusion that existed in screw thread sizes. In the early seventies they were building a line of bolt-threaders, largely used in railroad shops, but there was such a great variety of screw sizes and leads of thread that it was practically impossible to carry a stock that would meet the requirements of different shops. An inch bolt might be almost any size except one inch diameter. It might be 1-64 inch over or under the size, and might have a half-dozen different leads of thread. The establishment of standard sizes led up to the adoption of the U. S. or Sellers standard screw threads now in general use. The first set of standard P. & W. plugs and gages to be publicly exhibited was shown at the Centennial Exposition in Philadelphia in 1876. In this connection Mr. Whitney tells of an interesting discovery, which although now well-known, had not hitherto been realized. The plugs and gages for the exposition were made with the utmost refinement and were ready some weeks before its opening. Just before sending them they were tested, and to the astonishment of all concerned, it was found that they could not pass the crucial test required. They were refitted and sent to Philadelphia, and after receipt there were again tested and strangely enough were again found to be out of truth. It was then demonstrated, perhaps for the first time, that tool steel in any shape changes for a long time after being hardened and requires "seasoning" before it can safely be finished to exact size.

In 1893 the Pratt & Whitney Co. sold their business to a syndicate of New York bankers but Mr. Whitney retained his connection with the firm as superintendent and vice-president up to 1898, and then became president, retaining this position until the absorption of the business by the Niles-Bement-Pond Co., whereupon Mr. Whitney retired from active business.

He is now a director in several important Hartford enterprises and is treasurer of the Whitney Mfg. Co., which was organized in 1896, and is at present owned by him and his son, C. E. Whitney.

The accompanying photograph was taken in 1900 on the fiftieth anniversary of the date when he came to Hartford. He spent the day visiting the various places in Hartford where he had worked, and renewing old acquaintances and memories.

* * *

The manufacture of wrought iron tubes was commenced in this country some time between 1830 and 1834 by the firm of Morris, Tasker & Morris, according to the statement of Mr. Henry G. Morris in an article on the subject appearing in the October issue of the *Valve World*. A small welding furnace was built in the cellar of the shop at Third and Walnut Streets in Philadelphia and William Griffiths, a pipe welder from England, was hired to make the first pipe.

THE DRAWING OF CARTRIDGE-CASES FOR QUICK-FIRING GUNS.*

The development of the quick-firing gun has at once necessitated, and been rendered possible, by improvements in ammunition with a view to quick loading. Quick-firing guns differ from ordinary guns in having the propelling charge and the means of ignition contained in a metal case. The projectile may or may not be attached to the case, forming a complete cartridge, as this depends on the size of the gun. In ordinary guns the projectile, the propelling charge, and the primer or means of ignition, are all separate, the charge being usually contained in a combustible silk cloth or serge case. The advantages which metal cases present as compared with combustible cases are: (1) They are quicker in loading, since the primer forms an integral part. (2) The same reason reduces the probability of a miss-fire. (3) The sponging-out of the gun, to avoid the possibility of the burning remnant of a combustible case prematurely igniting the next charge, is avoided. (4) The expansion of a brass case under fire enables it to act as a gas-check, rendering the use of an obturator unnecessary.

Simultaneous loading with "fixed" ammunition, in which the projectile is attached to the cartridge case, is practiced with quick-firing guns up to about 3 inches diameter, above which size complete cartridges would be too unwieldy. Between 3 inches and 6 inches, therefore, separate loading is the rule, with the projectile separate from metallic cartridge case. Above 6 inches the gun ceases to be called quick-firing, and combustible cases with separate loading are used. Separate loading for larger quick-firing guns is desirable, not only because of the excessive weight of a complete cartridge, but also because of the danger of storing loaded and fused shell in the same magazine with loaded cases. With separate loading, the projectile may be placed near the gun at leisure, the cartridge-cases not being taken from store until the last moment. Such different conditions govern the storage, transport, and use of projectiles and of cartridge-cases that it is undesirable to attach them together.

Cartridge-cases for quick-firing guns are universally made of brass, this material having been found to possess the qualities best suited for this exacting service. Of all the numerous alloys that of copper and zinc, commonly called brass, ranks as one of the most important. At one period the generic name of bronze was given to this alloy as well as to that of copper and tin, to which it is now applied. The two alloys, copper-tin and copper-zinc are each characterized by well-defined properties, and each should retain its proper name of brass and bronze respectively. No other metal or alloy, not even excepting iron, presents such widely varying qualities, or so great a field of application. Commercial brass consists of two parts of copper and one of zinc, and is used, with certain exceptions, in all countries for cartridge-cases, not only for rifles but for quick-firing guns. The exact composition is 67 per cent of copper and 33 per cent of zinc, with a margin of 5 per cent above or below for either metal. The French artillery department, which is noted for the care with which its specifications for cartridge-case metal are drawn up, not only specifies the above-named proportion and variation, but requires that the constituent metals shall be of accepted brands, and of known origin, the sources of supply of copper being limited to the following: "Calumet and Hecla," "Tamerack," "Ovscila," "Atlanta," "Franklin," "Quincy," "Wallaroo," and that manufactured by electrolytic deposition. The brands of zinc specified are: "Vieille Montagne," known as "Extra Pure Fonte d'Art," "Oeschger Mesdach," "O.M. Art Zinc," and that of the Royal Austrian Company of Spain, known as the "R. C. A. Refinado." Subject to certain limitations, the use of scrap brass is also allowed.

The entire manufacture of metallic cartridge-cases involves a series of operations which, with the exception of two or three, consist in cold-drawing. The brass used is capable of extreme deformation when cold, but cannot be worked hot. After being formed into a cup-shaped disk, the metal is subjected to successive drawings, the object of which is to diminish the diameter and thickness and increase the length, the volume undergoing no sensible alteration. At each draw-

* Abstract of Paper by Col. Leandro Cubillo of Trubia, Spain, and Mr. Archibald Head of London, before the Institution of Mechanical Engineers, October 2, 1905.

ing the metal is deformed to a point short of the breaking point, every drawing operation being followed by annealing until the desired form is obtained, namely, a long cylinder with thin walls, and closed at one end.

The earlier operations, while the cartridge-case is still short, are carried out in a vertical press, but when the length is such that the manipulation and the withdawal of the punch become difficult, the operation is continued in horizontal presses. The two most important tools are the punch and the die. The punch is carried upon the extremity of the ram of the press and transmits the power, acting upon the bottom of the cartridge-case, which is inserted in the larger end of the die, the latter being strongly secured to the head of the press opposite the hydraulic cylinder. The die consists of a ring of hardened and tempered steel, the interior having the shape of a truncated cone, the axis of which is in a straight line with that of the punch. The operation of drawing is performed by placing a partly-drawn case, properly centered, in the larger end of the die, and advancing the punch until it touches the bottom of the cup. The pressure then comes into play, forcing the cup through the small end of the die, thereby reducing the diameter of the cup and the thickness of the walls and increasing the length, a process which involves considerable flow of metal.

During the process of drawing, the cartridge-case is subjected to stresses in general oblique to the surface, represented by P (in the stress diagram in Fig. 1). This stress may be resolved into two, one of which is normal and the other tangential to the surface of contact between the brass and the die, called respectively N and T. If E represents the total pressure exerted by the punch upon the bottom of the cartridge-case, it is clear that equilibrium will exist when the vertical components of the normal and tangential forces are together equal and opposite to the force E. If a is the angle formed by the wall of the die with the axis of the punch, the equation of equilibrium will be: $E - T \cos a - N \sin a = 0$. Thus it will be seen that the forces N and T vary with the magnitude of the angle a. As this increases $\sin a$ increases and $\cos a$ diminishes, and consequently the values of the components T and N also decrease and increase respectively. When $a = 90$ deg. $\sin a = 1$, and $\cos a = 0$, and E is then equal to N. When $a = 0$ then $\sin a = 0$ and $\cos a = 1$, E being equal to T. In the first case this stress would be entirely normal, and in the second case entirely tangential and tensile. The two extreme cases, however, never occur. In practice the flow of the metal is never achieved by simple tensile forces, and compressive forces are always present. The drawing of a 6-inch cartridge-case will now be described in detail:

Cupping.—The cupping is divided for convenience into two stages, the first being done with the punch and die illustrated in Fig. 2. Before commencing it is necessary to center the die relatively to the punch, the breadth of the annulus being measured at three points. The stroke of the punch is then adjusted, so that at the end of each stroke it does not exceed what is necessary to thrust the disk clear through the small end of the die, and so avoid waste of time and power. At the commencement of the stroke an extra length of stroke of from 4 inches to 8 inches is given in addition to the amount actually necessary to clear the die, in order to give the operator time tc place the disks upon the die. The die, punch, and disk are then well greased, and the latter is placed upon the upper surface of the die. Water is admitted to the cylinder and the punch advances, driving the disk through the die and out at the smaller end, whence it falls in the form of a cup into a receptacle placed below the press. The maximum pressure attained is 1,000 pounds per square inch, as shown by the gage attached to the hydraulic cylinder. The cup is then annealed for about 28 minutes at 1,364 degrees F., having a steel clip placed round it. The scale which forms on the surface of the cup is subsequently removed by pickling in lead-lined wooden troughs containing dilute sulphuric acid, of a strength of 1 to 4, for a period varying from 8 to 15 minutes according to the strength of the bath. The cups are then washed by immersion in lead-lined wooden troughs, through which runs a stream of water, every trace of acid being quickly removed. The second cupping operation is made in exactly the same manner as the first, except that the punch and die shown, Fig. 1, are substituted for those previously used, the same precautions being observed for centering and lubricating. The maximum hydraulic pressure indicated by the gage is 1,150 pounds per square inch, while the subsequent annealing lasts 20 minutes at a temperature of 1,202 degrees F. The pickling and washing processes which follow this and all other annealings are as before described. The behavior of the metal during cupping is an efficient test of its quality. The presence of impurities or improper annealing are quickly shown by cracks or a roughened surface.

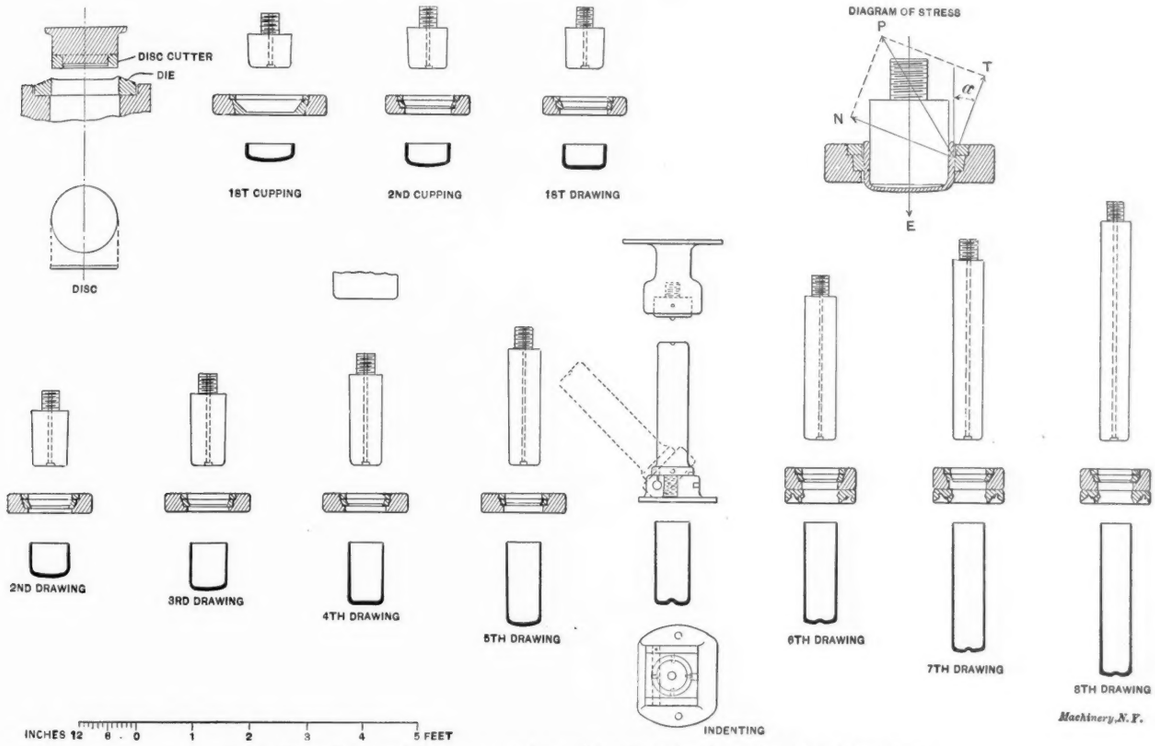


Fig. 1. Press Tools and Processes used in making Cartridge Cases for Quick-firing Guns.

First Drawing.—Fig. 1 shows the punch and die used in this operation, also the resulting piece. The maximum hydraulic pressure is 1,300 pounds per square inch. The pieces are then annealed at 1,202 degrees F. for 28 minutes.

Second Drawing.—This is performed with the tools shown in Fig. 1 with a maximum hydraulic pressure of 1,350 pounds per square inch. The subsequent annealing is at 1,202 degrees F. for 26 minutes.

Third Drawing.—This is performed with the tools shown, with a maximum hydraulic pressure of 1,320 pounds per square inch. The subsequent annealing is at 1,184 degrees F. for 25 minutes.

Fourth Drawing.—Before drawing, the bottom of the piece is flattened preparatory to indenting, which takes place after the fifth drawing, and is necessary for the formation of the primer hole. Flattening is accomplished by pressing the piece between the punch and a flat steel disk supported on the die. The disk is then withdrawn and the drawing proceeds as usual. The tools are shown. The maximum hydraulic pressure is 1,000 pounds per square inch, and the subsequent annealing is at 1,166 degrees F. for 22 minutes.

Their expansion at the moment when drawing is complete, and when they are relieved from the considerable lateral pressure, prevents their being again drawn up through the die by the retreating punch. But from the sixth drawing onward, the lateral pressure is less, and other means are adopted. Under each die is an attachment containing eight fingers pressed inward toward the axis by springs. During drawing, they give way before the advancing case, retiring into recesses. But when the end of the case has passed them they spring out and keep the case from following the punch back, the inclination of the recesses in which they move assisting this action. The sixth drawing may be performed either on the 18-inch or the 16-inch horizontal press, either having sufficient power. The subsequent annealing is at 1,166 degrees F. for 18 minutes.

Seventh Drawing.—The tools used for this operation are shown. The subsequent annealing is at 1,166 degrees F. for 15 minutes.

Eighth Drawing.—The tools used for this operation are shown. The subsequent annealing is at 1,112 degrees F. for 14 minutes.

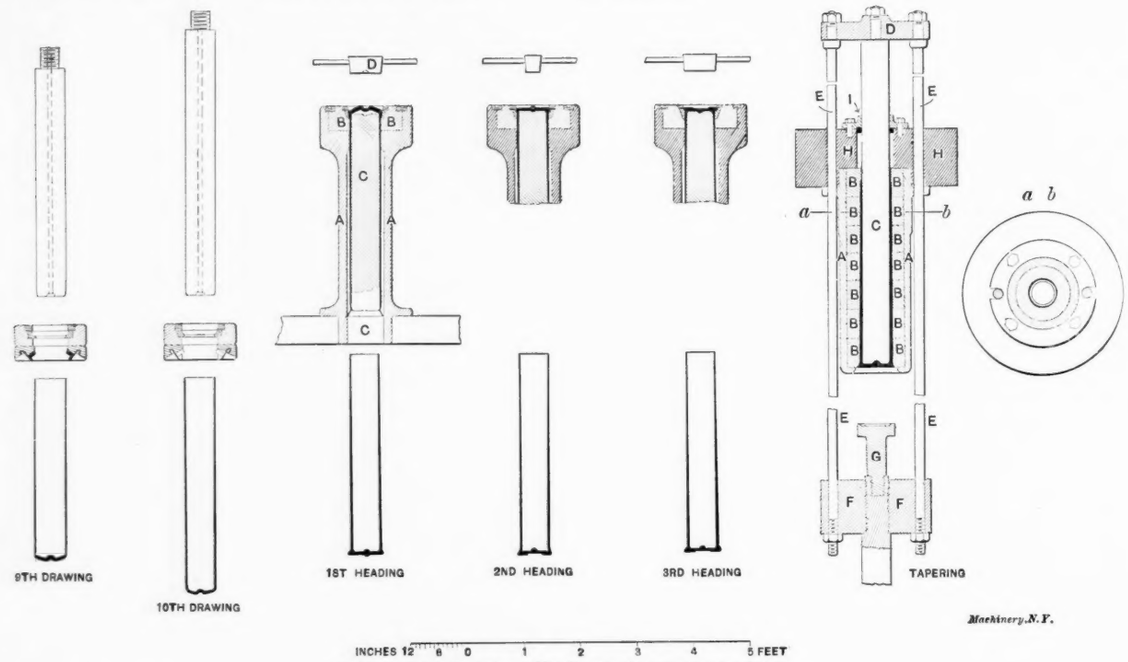


Fig. 2. Finish Drawing. Heading and Tapering the Cases

Fifth Drawing.—This is the last operation performed in the vertical press. The tools used are shown, the maximum hydraulic pressure being 700 pounds per square inch. The subsequent annealing is at 1,166 degrees F. for 20 minutes.

Indenting for Primer.—This operation is performed in the vertical 1,000-ton press. Upon the ram which moves upward is placed a pressure plate, to which is hinged a steel punch-shaped piece having the same external form as the interior of the cartridge-case as it leaves the fifth drawing, and with an indentation at the top. This can be hinged to one side to facilitate the insertion and withdrawal of a cartridge case. Upon the under side of the upper head of the press is a fixed holder, into which is screwed a flat piece of tempered steel having a small projection in the center. The object of this is to form, in conjunction with the recess in the punch, the metal boss on the inside of the case, for the primer. The cartridge case is subjected to a pressure of about 314 tons between the two surfaces, with a hydraulic pressure of 2,500 pounds per square inch. No annealing is required after indenting.

Sixth Drawing.—From this operation onward the two larger of the three horizontal presses are used, because the length which the cartridge-cases have now reached does not permit of their manipulation in the shorter-stroke vertical press. The tools used for the sixth drawing are shown. Up to this point the cartridge-cases have been able to strip themselves from the punches by catching on the underside of the dies.

Ninth Drawing.—The tools used for this operation are shown in Fig. 2. The subsequent annealing is at 1,058 degrees snap," for it is no such thing.

Tenth Drawing.—The tools used are shown in Fig. 2. This is the last drawing operation, and the blanks undergo no annealing upon its completion.

Heading.—The formation of the head of the cartridge-case is one of the most interesting of the operations in the process of manufacture. The total pressure which the head of the cartridge is called upon to stand under fire is enormous. With the 6-inch quick-firing gun used in the Spanish service, for which the cartridge cases are intended, the pressure caused by the explosion is about 17 tons per square inch. Even this pressure is exceeded when testing the guns, which is done with three discharges at a pressure of 20 tons per square inch. When the area of the cartridge-case head is considered, some idea may be formed of the enormous aggregate pressure to which it is subjected. It is essential for the satisfactory working of the guns that no deformation should take place under fire, and it is therefore important that during manufacture the head should be subjected to a pressure two or three times that likely to be experienced in practice. The operation of forming the head is made in the vertical 2,500-ton press in three stages. The tools used for the first stage are shown in Fig. 2. An iron casting, *A*, termed a bolster, is placed upon the ram of the press and serves to support the die-holder and die *B*—which latter imparts the form of the

flange to the head. Inside the bolster is fixed a steel stem *C*, over which the cartridge-case is slipped in the condition in which it leaves the tenth drawing. This stem, which must be capable of withstanding an aggregate pressure of 1,650 tons, is of the best hardened steel, and is without question the most delicate of all the tools employed in the process of manufacture. The first heading operation is performed by inserting the cartridge-case between the stem and the bolster. Upon the top is also placed the punch *D* of hard steel, provided with a central depression, the object of which is to reduce the area of contact over which pressure is exerted on the head of the cartridge-case. The total pressure is 1,600 tons, which leaves the head with a central internal and external projection, and forces the metal outward to form a flange.

In Fig. 2 is shown the second heading operation. This is performed with the same tools as the first, except that a smaller punch, 3 inches diameter, is placed over the cartridge-case, instead of the punch *D* previously used. A total pressure of 600 tons is exerted, with the result that the outside projection is flattened, and all the metal is driven into the internal boss, thus allowing sufficient metal for the primer holes. Finally, the third heading operation is performed with the tools shown, a total pressure of 1,650 tons being applied, with the result that the head is rendered flat and shapely.

Tapering.—This operation is for the purpose of giving to the cartridge-case its final external form, enabling it to fit the chamber of the gun, and to be easily inserted and withdrawn. It is performed in one or the other of the horizontal presses, in order to take advantage of their longer stroke. To the fixed head *H* of the press, Fig. 2, is bolted the cast-iron bolster *A*, inside which are placed seven rings of tempered steel *B*, the internal length of which when thus assembled is exactly equal to that of the gun chamber. The cartridge-case is driven into this space by the press, but as it is necessary forcibly to extract it after the operation, the special apparatus shown is made use of. The cylindrical extractor *C*, having a head shaped to fit the inside of the headed cartridge-case, is connected rigidly with the ram of the press through the crossheads *D* and *F* and the tie-rods *E*, and moves therewith, its position being kept central by the guide *I*. The punch *G*, bolted to the ram of the press, forces the cartridge-case in during the forward stroke, while the extractor *C* forces it out during the return stroke. At Trubia the tapering is divided into two operations with annealing between, to avoid risk of cracking. Before the first tapering the cartridge-case is annealed at 1,040 degrees F. in a small vertical furnace, care being taken to allow the head to remain outside the furnace in the air. It is then placed in the press and forced about half its length into the chamber, the precaution being taken to adjust the stop of the press so as to limit the stroke to half its usual length. On the return stroke, by the aid of a wooden distance-piece inserted between the extractor and the head of the cartridge-case, the latter is forced out. The case is then returned to the vertical annealing furnace, where it is exposed to a temperature of 932 degrees F., care being taken as before not to anneal the head. Tapering is then completed in the press, the cartridge-case being driven completely home into the die chamber.

Other Mechanical Operations.—The remainder of the operations are of a mechanical nature, such as turning the end, the head, the steps in the chamber, the attachment for the primer, cutting to the exact length, etc., none of which involve any features of special technical interest. It may, however, be mentioned that throughout the whole course of manufacture the thickness and diameter of the cartridge-case are carefully checked with calipers and gages, and particularly for the first two or three cases in each lot, in order to verify the accuracy of the dies and the setting of the tools. The ends of the cases are frequently turned to length between the various drawing operations, since there is a tendency, due either to the irregularities of metal or to uneven annealing, to stretch unequally, leaving ragged edges. It is also of great importance that the thickness of the end of the cartridge-case should be closely checked, and this is performed by limit gages. Lubrication of the punches and dies is effected by olive oil or soapy water.

PRACTICAL DONT'S FOR MACHINISTS--2.

H. E. WOOD.

Don't argue with your foreman.

Don't make hammer marks in your work.

Don't run your lathe tool into the faceplate.

Don't use unfaced nuts in building a machine.

Don't show your prejudices against "jig work."

Don't lay out scratch lines on a sandy surface.

Don't sharpen a thread caliper to a sharp point.

Don't let your lathe tool strike the chuck jaws.

Don't let your file strike against the vise jaws.

Don't leave brass or emery in your eyes over night.

Don't try to mark tempered tools with steel letters.

Don't try to knurl a piece of work without oiling it.

Don't use a chisel dry to chip boiler plate or steel.

Don't put a hacksaw in the frame backward; it is bad.

Don't make a shaft exactly to size, or length, when it is warm.

Don't break a tool, and then say: "It was broken when I got it."

Don't run a lathe an instant after the center begins to squeal.

Don't be too quick to laugh at the way a new man goes at a job.

Don't run a hacksaw blade up close to the end of your vise jaws.

Don't forget to oil your machine every morning; it works better.

Don't let a lathe dog's tail pinch against the slot in the faceplate.

Don't do a job of scraper work without crossing the scraper marks.

Don't cross the belt on a drill press when a green boy is using it.

Don't forget that oil is one of the best friends that machinery has.

Don't blow filings or chips in among the running parts of a machine.

Don't do any chipping unless you know where the chips are flying to.

Don't tamper with adjustable dies or reamers, outside of the toolroom.

Don't forget to stamp the "part numbers" on all parts of a new machine.

Don't use a wrench on a tap or reamer shank that is too large to fit it.

Don't put an oil-hole at each end of a bearing, without one in the middle.

Don't interfere with a machine when another man has a job set up in it.

Don't forget that red lead works better in some places than black lead.

Don't hide the lathe tools and dogs so that other workmen can't find them.

Don't drill sheet metal or brass with a twist drill; use a "farmer drill."

Don't forget that a line measurement is not the same as an end measurement.

Don't forget to provide oil-holes to supply all running parts of a machine.

Don't forget that cast iron scale is harder than tempered tool steel.

Don't use a cup-point setscrew in a tight pulley if you can get a round point.

Don't use a single lip planer tool when you can conveniently use a gang tool.

Don't stick files on end in the floor, someone may accidentally fall on them.

Don't dispute your foreman's authority, even if you know he is not a machinist.

Don't fail to observe system in your detail work, either at the lathe or bench.

Don't use taper wedges to shim up under planer work, but always use flat shims.

Don't forget that a cutting-off tool should have equal clearance on both sides.

Don't think that the road man machinist has an "easy snap," for it is no such thing.

Don't grind a shaper or planer tool with as much clearance as you would a lathe tool.

Don't say "I just oiled it" when the machine you are operating sticks for want of oil.

Don't use the corner of a steel rule for a scratch awl, or to mark on rough castings.

Don't forget that a fairly good center-punch may be made from a piece of a round file.

Don't get into the "rut" of doing your lathe work the same as your father always did it.

Don't forget that cast iron will crawl or spring every time you take a chip off from it.

Don't forget that vise jaws are hard, and should not be struck with the file or hacksaw.

Don't forget that a combination square blade with two stocks makes an excellent try gage.

Don't allow hot babbitt metal to come in contact with water, or moisture, or rust.

Don't forget that there is air in an oil channel that cannot escape unless it has a vent.

Don't pull harder on one end of a tap wrench than you do on the other; it makes bad work.

Don't make a finishing cut on cast iron with a fine feed; a wide feed looks much better.

Don't think that a laborer who has been in one shop for years, knows nothing about the work.

Don't clamp a piece of work into a milling machine vise without the proper support under it.

Don't face off a large disk in a lathe chuck without a support from it to the tailstock center.

Don't hold a mill file at right angles to the shaft in a lathe if you want it to cut very fast.

Don't forget to make allowances for expansion and contraction when working on steam engine work.

Don't say "someone must have hit it," when you have broken a tap off in work through negligence.

Don't try to wipe dust or iron out of your eyes with cotton waste; the waste is dangerous.

Don't forget that a flywheel, pulley, or handwheel, should be balanced up before leaving the shop.

Don't pour babbitt metal into any place for machine work without having a riser at each extremity.

Don't forget that one of the hardest jobs to do, is to file a surface exactly flat and straight.

Don't forget that the warmth of your hand will change the size of a caliper or gage of any kind.

Don't forget that chloroform and camphor makes a good solution to use when drilling tempered steel.

Don't forget that the hardest fit to make on a lathe is what is called a wringing or twisting fit.

Don't try to start a plug tap in a hole when it is convenient to start the thread with a taper tap.

Don't try to put a second tap through a clearance hole and strike the thread made by the first tap.

Don't forget that a surface, polished with oil will keep clean much longer than one polished dry.

Don't forget that a round piece of work can be made on a planer, and a square piece on a lathe.

Don't depend on friction to hold a piece of work on a planer bed, but put positive stops against it.

Don't brush dirt or chips off from any part of a machine unless you know where they are falling to.

Don't open the shop windows and let the cold damp air blow in onto newly finished parts of machinery.

Don't try to strengthen a cold rolled shaft with one end in the chuck and the other end on the center.

Don't laugh at a machinist who has learned his trade in a "one-horse job shop" for he may outclass you.

Don't forget that the greatest of all the secrets of the machinist's trade lies directly between the caliper's points.

Don't pour babbitt metal into a damp clay runner without covering the exposed surfaces with oil; kerosene is the best.

Don't peen a shaft straight and expect it to run true after a cut has been taken over the spot that has been peened.

Don't refuse to tell or show the apprentice what to do, for you once had to learn all that you know.

Don't forget that more time is lost between changing tools and changing pieces, than while the tool is running.

Don't forget that plumbago, graphite, or black lead, will prevent a shaft from running hot sometimes when oil fails.

Don't forget that a round file and a monkeywrench together, will make an excellent pipe wrench in emergency cases.

Don't forget to make sure that your tap carries the same number of threads per inch as the bolt, before tapping the hole.

Don't forget that a strong blast of cold air works very similar to oil upon a drill, and in many cases does better service.

Don't forget that many different chisels or tools may be used for drawing a drill hole over to the center where you want it.

Don't run a reamer into a piece of work in a lathe chuck without having your toolpost and carriage up against it to prevent it from running in too fast and breaking something.

Don't let your bolt slots fill up with chips and dirt; it is better to fill them up with strips of wood fitted up for the purpose. This will also save your time in cleaning up your machine.

Don't cast a solid babbitt box around a bare shaft if you expect to get it out easily. A piece of thin paper (coated with a little common soap to make it stick) wrapped around the shaft will be a great help.

Don't forget that it is extremely bad practice to lay anything hard of any kind on the ways or bed of a lathe; it is best to always keep the bed covered with smooth boards fitted up purposely.

Don't always blame the hand die if it crumbles the thread on a bolt, for the fault may arise from clogging up of chips, lack of proper kind of oil, lack of hitching back and forth, or lack of judgment in many ways.

Don't forget when you are tightening or loosening the bolts in a bracket or cap you should not make one bolt tight before the others are nearly up to their places, and should never take one bolt clear out until all the others are loosened up.

* * *

"HOW HE CUT OFF THE FILE."

He was a big burly Swede, and the boss thought he had a prize. He said he "did file some little," so the boss gave him an eighteen-inch bastard file (what the boys sometimes call a hand-planer) and started him in on cleaning up a lot of castings. It was a warm day, and the fellow took hold of the job with a will and worked like a Trojan. Now an eighteen-inch file is not an easy tool to run, and "Swedy" had an inspiration. Down at the lower end of the room there was a big pair of bar

shears, used for shearing up railroad iron. Why not cut off about four inches of that eighteen-inch file, and make it easier to run? Down he went to the other end of the room, and waiting until the blade of the shear came up, he shoved in the file. There was a crash and two hundred pounds of Swede went flying through the air and landed against the side of the building with a broken arm. The king bolt on the shears was broken and a big bite taken out of the upper knife—but he cut off the file.

A. P. Press.

MILLING MACHINE FIXTURES.—3.

E. R. MARKHAM.

We often have to mill articles of cast iron or other metals which are not uniform in size or shape, and which would not bed alike in any fixture, without means of compensating for the irregularities. The writer has seen columns of milling machines, which weighed 400 or 500 pounds, sprung out of true when on the planer table by tightening a holding bolt,

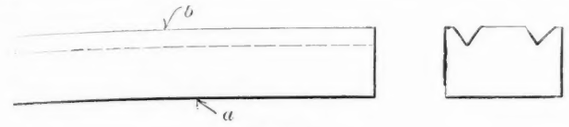


Fig. 27.

and the wrench used was an ordinary 6-inch wrench apparently applied with small force. To secure a good job, it was necessary to block under the piece very carefully and then fasten it securely for the roughing out, and for the finish cuts the strain on the clamps had to be removed entirely, or nearly so. If it is possible to spring a large mass of metal in this manner, it is apparent that comparatively weak pieces may be distorted very easily. For this reason it is necessary many times to provide adjustable supports at the points where

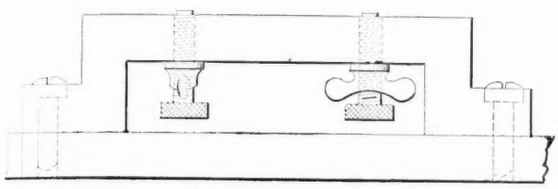


Fig. 28. Fixture for Holding the Piece shown in Fig. 27.

the fastening devices are located and also at points where the pressure of the cutter would have a tendency to spring the piece.

Fig. 27 represents an iron casting, the surfaces of which are to be milled. As castings will distort more or less in cooling, and as they are very liable to alter their shape when the surface "skin" is removed, it is often necessary to provide fixtures with adjustable supports for holding the piece, as shown in Fig. 28. In milling a piece like that of Fig. 27, such

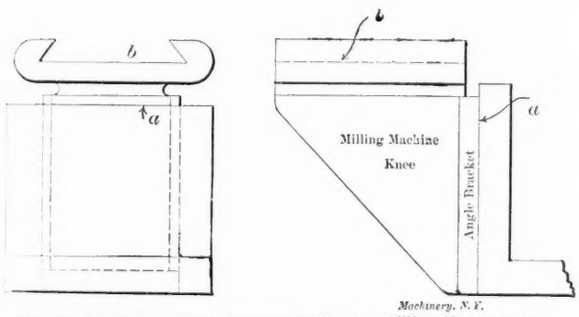


Fig. 29. Methods used to Accurately Finish a Milling Machine Knee.

a fixture should be used when taking roughing cuts on surfaces *a* and *b*, and the finish cuts on surface *b*.

In the case of work that must be very accurate as to dimensions and truth of finished surfaces, it will be found necessary to finish the surface *a* approximately true by means of grinding or scraping before milling the surface *b* for finish. This is especially true with such work as the knee of a milling machine as shown in Fig. 29, where it would be necessary to rough drill the surfaces *a* and *b* and finish mill *a*. After this, the knee should be "rough scraped" to give it a bearing against the fixture and to prevent it winding or twisting, as would be the case if the surface *a* were not true and were clamped against the fixture. To attempt to scrape these surfaces and get out a wind occasioned by inaccurate milling, owing to one of the surfaces not being flat against the holding device, when the finishing cut was taken over the other surface, would cause much needless expense.

While the above remarks are applied directly to the milling of a milling-machine knee, they are equally applicable to any piece of work that must be true, and yet whose shape or material renders it liable to spring as a result of some machine operation.

There are jobs which require a number of cuts on one side and which must be of a certain *uniform* depth from a given surface. If the pieces are of a uniform thickness they may be held in the usual manner, by having the under side of the piece bear against the seating surface of the fixture and the

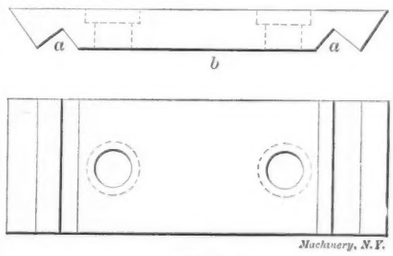


Fig. 30.

cuts taken on the upper side. If, however, the pieces are not of a uniform thickness and the cuts must be of an exact depth some other method of holding must be employed. Fig. 30 represents a cap used for holding a traveling carriage in place on a knitting machine. The V grooves *a a* must be of given depth from the surface *b*, and owing to certain conditions it is practicable to mill that surface at the time the grooves are milled. The distances from the screw holes must also be equal.

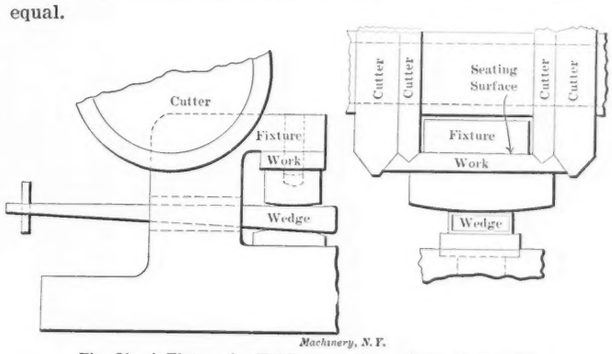


Fig. 31. A Fixture for Holding the Piece shown in Fig. 30.

A fixture of the design shown in Fig. 31 was made to hold the cap when milling the V slots and bevel on ends. It will be observed that it is an inverted fixture and that the surface *b* of the cap, which has been previously milled, rests against an under surface of the fixture. Pins which fit the screw holes in the cap project from the seating surface of fixture and enter these holes, thus properly locating the cap, which is securely held against the seating surface by means of the wedge. Between the wedge and cap is placed a block, as

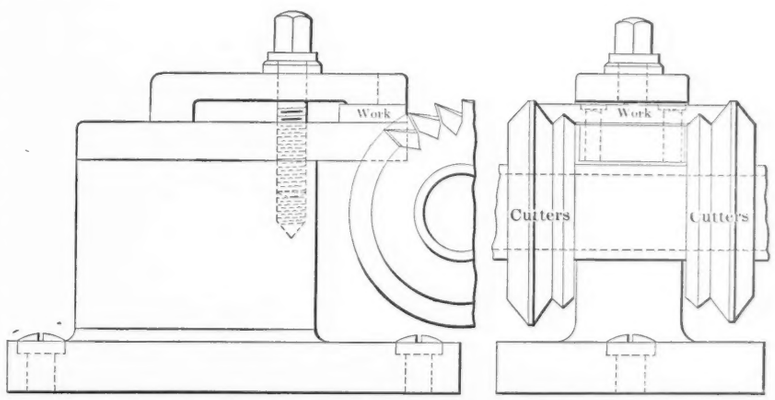


Fig. 32. Alternative Fixture for Holding Work shown in Fig. 30.

shown. When the wedge is driven forward the block may be removed and the cap taken from the fixture. The pin at the thin edge of the wedge prevents the wedge from being driven entirely out of the fixture.

A fixture of a different design, which somewhat simplifies matters, was made for this job, but as it was but little out of the ordinary I will not describe it. My idea in describing the above design is that at times it is necessary to use a fixture of this character.

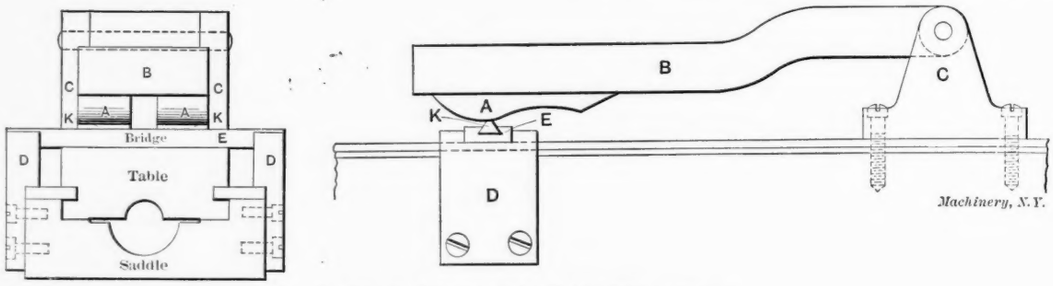


Fig. 33. The Principle of the "Bridge Milling" Fixture.

At times when fixtures of the character mentioned are to be used it is wise to make them of the style shown in Fig. 32, the cutter being beneath the fixture. In this case the seating surface being uppermost is more easily cleaned than when a fixture as shown in Fig. 31 is used.

BRIDGE MILLING: A method of milling a certain class of work which is not used so extensively as it was a number of

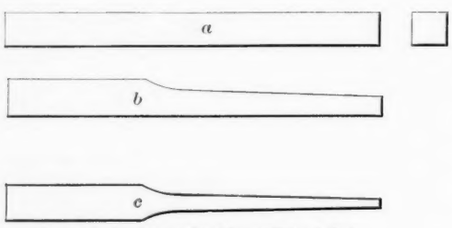


Fig. 34. Sample of "Bridge Milling" Cuts.

years ago, and which is entirely unknown to many mechanics, is known as bridge milling. In some shops work is done on profiling machines which might be done in a satisfactory manner by this method and at a fraction of the cost.

The desired shape is produced by means of a form, *A*, which is securely fastened to the movable leaf, *B*, of the fixture, as

Fig. 35. Milling Cut on a Bicycle Crank.

shown in Fig. 33. This leaf is swung between two uprights, *C C*, by means of a heavy steel pin. The base of the uprights is securely fastened to the table of the milling machine by screws. To each side of the saddle, and directly opposite each other, are fastened posts, *D D*, which support the bridge, *E*, reaching across the table. The bridge should be located but a trifle above the table, say 1-1,000 inch, in order that the table of the

Fig. 36. Handle for Cutting Pliers.

machine may prevent it from springing more than that amount when pressure is exerted by the operation of cutting.

In the surface of the bridge is cut a slot to receive a hardened steel piece, *K K*, which, being narrow at the top, allows the movable leaf to move in conformity to the shape of form fastened to its under side.

Fixtures of this character may be used many times for milling a number of pieces at once. I recall a fixture for milling the legs of machinists' calipers. These were milled from pieces of square machinery steel to the shape shown in Fig. 34, where *a* represents the piece of mild steel cut to length, *b* after one side was milled to shape, and *c* after both sides had been milled. Eight pairs of legs were milled at a time and at a fraction of the cost of drop forgings.

At another time we rigged up a fixture for bridge milling the flat portion at the end of the bicycle crank, Fig. 35. As in the case of the caliper legs, we used a double fixture and were able to mill six pair of cranks at a time, milling the right-hand crank in one fixture and the left-hand in the other. These were located side by side on the same machine. On account of the unequal quantity of stock removed at the various portions a slight inaccuracy was observed, but was corrected by running the cutters across the work twice at the same setting of the pieces.

At another time we found that by substituting the operation of bridge milling for that of profiling we were enabled to mill the rounded portion on the cutting upper handles shown in Fig. 36 at a fraction of the former cost, and at the same time opened the way to do other work on the profiling machine, thus enabling us to get along without adding to our equipment as would otherwise have been necessary.

Fig. 37

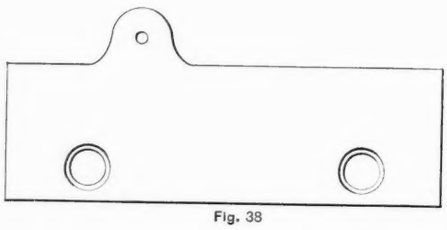


Fig. 38

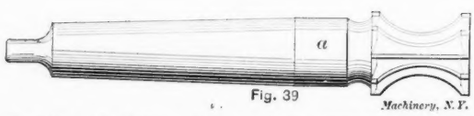


Fig. 39

Fig. 37. Vernier Sight Base. Fig. 38. Vise Jaws used for Work shown in Fig. 37. Fig. 39. Form Cutter with Guiding Surface.

In the first two examples of bridge milling cited, the milling was done with straight cutters, whose teeth were cut spirally, the helix being right-hand on one cutter and left-hand on the others, to do away with the thrust incident to long spiral mills where the teeth of both are of the same hand helix. In the case of the cutting nipper leg the cutter used was concave in shape.

The old adage that "Necessity is the mother of invention" is nowhere more apparent than in the small shop where a great variety of work is done with a limited equipment. The fact that work is done in comparatively small "batches," with little assurance that another lot will ever be made, renders it inadvisable to procure machinery specially adapted to the work, and it is found necessary many times to use the planer for a job of broaching, or a punch press to do work that would be done on a key-seating machine if one were at hand. In

fact, it is found necessary to use a machine for purposes that under other circumstances would be considered but ill adapted to the work in hand. For this reason we find many of our best mechanics are those who learned their trade in the kind of a shop just mentioned. A few years' experience of this kind develops the faculty of thinking to a degree that would not be probable without such experience.

I recall a piece of work—a Vernier sight base—Fig. 37, which it was necessary to round on its upper portion. At first thought this appeared to be a job for the profiling machine, but that machine was taxed to its utmost capacity, so a pair of jaws of the form shown in Fig. 38 were made. The upper portion of the stationary jaw was made to act as a former and the jaws were fitted to the vise on a hand milling machine. The cutter was of a shape that insured its cutting the desired curvature on the base, and a portion was left as shown in Fig. 39 at *a* to rest on the form part of jaw. This was found to work very nicely. It was, of course, necessary to harden the jaw on the portion used as a form, so it was quite hard. The portion of shank of the mill marked *a* was left quite hard and was ground to insure its running true after the shank was ground to fit the collet.

Since making these jaws, the writer has had occasion to make many others for use in machining other gun and bicycle parts, and in some cases has found them to work more satisfactorily than when the same pieces were machined on a profiling machine.

* * *

GAS ENGINEERING IN THE ORIENT.

"TRAVELER."

The working of the minds of the simple and yet wonderfully studious peoples of the Orient, or even of the Anglo-Indians who have never been in manufacturing centers, is something which we machinery-using Americans cannot comprehend. Examples of the mental confusion which our unfamiliar appliances bring about in the novice occur occasionally to give us a pleasant jolt in the humdrum of daily work.

Some years ago the writer was engaged in engineering work in one of the large iron mines of northern Michigan. A big raw Finlander had recently been employed and broken in as a driller's helper. It was his duty to carry the tripod for a heavy drill, and he was taught to carry it by throwing one leg up over his shoulder, allowing the other two legs to hang down, grasping these with his hands.

The big Finn had mastered the details of this operation, and his great strength was rapidly winning him a place of favor with the driller; when one day he was sent into a neighboring stope after a wheelbarrow. He had never seen a machine of that class before, and at first could not see how he was going to get it from one stope into the other. He finally stood it up on the handles, grasped a handle in each hand, and holding the wheel up over his shoulder just as he would carry a drill tripod, stalked ahead. When he arrived in the other stope and was shown how such a complicated machine as a wheelbarrow was intended to be conveyed from one place to another, a great light and a very curious expression spread over his face. It had in it the elements of several conflicting and highly differentiated emotions.

If the non-machinery using European finds the wheelbarrow a machine requiring study, what must a modern gasoline engine be to the average Asiatic? Recently a man in charge of a machine shop in a small town in India purchased a gasoline engine from a prominent American manufacturer. The engine was properly crated and shipped, but in transit the book of instructions was lost. The engine had been mounted on heavy skids with most of the auxiliary apparatus in place. When it arrived at its destination it was dragged into the compound in which the machine shop was located by a patient elephant, always the common source of power of the Orient and of wonder on circus day to the small boy of the Occident.

They decided that it was not safe to take it into the shop before trying it, and hence the engine was set up in the yard, the boxing knocked off, all the necessary attachments made, batteries connected up, and the tank filled with gasoline. The next thing was to start it, but they lacked their book of instructions. One of the Europeans connected with the plant had the idea that all gasoline engines had to be started by rolling them continuously forward, but the makers of the engine under consideration had simplified the matter greatly in this case, as the engine is started by turning it forward until it sucks in a charge and then giving it a little over a quarter-turn back to produce the necessary compression previous to the firing of the charge.

Not knowing this the manager called a force of some twenty-five coolies, and attempted to start the machine by turning it continuously forward. This was very laborious work, and the men got bolder and bolder until they were clinging to every spoke of the pulley, and tugging as hard as they could. The compound was surrounded by a fence ten feet high, and practically the whole village had crowded into it to see the new machine. The engine made four or five revolutions before ignition took place, and this threw a good deal of charge into the exhaust pipe and muffler, so that when it finally started there was a deafening explosion in the exhaust pipe and muffler.

Fortunately the engine simply hurled its load of clinging humanity in every direction without injuring anybody, while the natives went over that ten-foot fence like a pack of monkeys, two of them landing with broken arms as the result of their haste. It was some time before even the boldest could be persuaded to come back to the compound, but they finally got used to the engine and then it was dragged into the shop and connected up for work; but the first job every morning had to be for the entire force of twenty-five or more coolies to get hold of the belts and flywheels and start the engine by rolling it over continuously against compression.

In due course of time the owner of the plant visited the United States and called upon the gas engine manufacturers.

"How do you like that 40-horse power gasoline engine you purchased?" said the manager.

"Oh, it runs fine; but why in the world don't you Americans invent some better way of starting it? It takes all the coolies I've got to start the engine every morning, after that it runs all right all day long, and takes very little or no attention."

"How do you start the engine?" inquired the manager.

Then followed a recital of the facts given above. Then they took a recess for the manager to laugh, and after he had got his breath once more he said, "I can start a 50-horse power engine alone."

"You must be stronger than you look, for it takes 25 strong coolies to start it with us."

The matter was settled by a visit to the testing floor, where the manager stopped four or five engines and started them all without any difficulty. The purchaser was very much surprised, and then incredulously wanted to try the trick himself. After starting the first engine and finding that he could really do it, he acted like a small boy with a new toy; got them to stop all the engines in the line, and went up and down the line along the length of the testing floor starting and stopping those engines for half an hour. He turned to the manager, "I wish I could go to India *to-night* and show them how to do this!"

The manager suggested sending a book of instructions, but the purchaser insisted that he would write the directions himself, and hurried off to the hotel, where he wrote a ten-page letter and started it off to suspend that 25-coolie operation.

* * *

Some interesting facts regarding the endurance of a centrifugal fan blower were brought out in the discussion at the last meeting of the Pittsburg Foundrymen's Association, regarding the relative merits of the positive blower and the fan. It was stated by a representative of the Westinghouse Air Brake Co. that they installed six positive blowers in their foundry and after six months replaced them with fans. At this plant the iron is melted continuously and the blowers were compelled to operate 23 hours daily. The blowers were operated at a pressure of 16 ounces and at the beginning of a heat would run up to 20 ounces. Regarding the life of fans, he said that they have used a No. 9 fan for 15 years, and during that period it was operated 23 hours every day except Sunday, and required no repairs whatever.

THE ALLIS-CHALMERS STEAM TURBINE.

A steam turbine recently started up at the Washington Street power house of the Utica Gas & Electric Company, Utica, N. Y., is the first to be put into operation by the Allis-Chalmers Company, and is shown in Fig. 1.

This turbine is rated at 1,500 kilowatt normal load, and runs at a speed of 1,800 revolutions per minute. It is direct-coupled to an Allis-Chalmers two-phase, 60-cycle revolving-field alternator, operating at 2,500 volts. The unit has a continuous overload capacity of 25 per cent., with a 3-hour 50 per cent. overload capacity without exceeding a safe generator temperature, and capable of a 100 per cent. safe momentary overload. Artificial ventilation by means of an electrically-driven fan blower will, however, enable the unit to be run safely beyond its rated overload capacity.

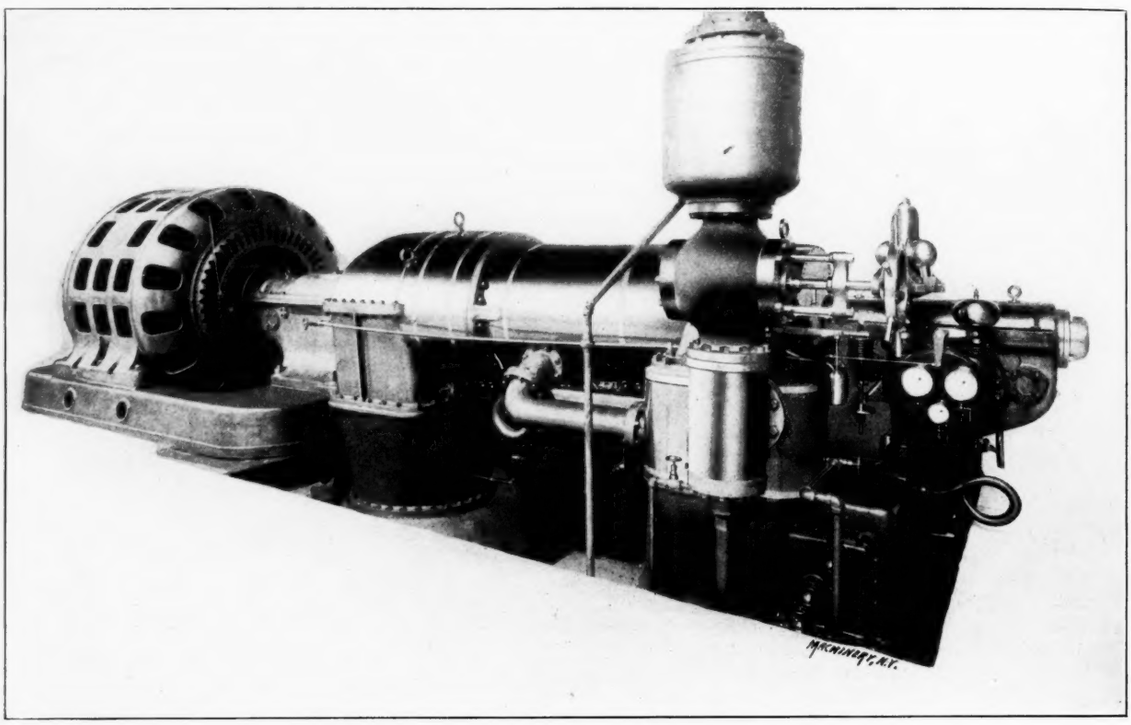


Fig. 1. Fifteen-hundred K.W. Allis-Chalmers Turbine Installed at Utica, N. Y.

The turbine follows the well-known Parsons type but embodies a number of features which are new in this country. The chief distinguishing feature is the blading. The roots of the blades are formed in dovetail shape by special machinery, and are inserted in slots cut in foundation or base rings; these slots being formed by special machine tools in such a way as to exactly conform to the shapes of the blade roots. The foundation rings themselves are of dovetail shape in cross section and are inserted in dovetailed grooves cut in the turbine casing and spindle respectively, in which they are held by key pieces, much in the same way that the well known "Lewis bolt" is fastened. In order to further insure the integrity of the construction, the key pieces or rings after being driven into place are upset into undercut grooves.

Another noticeable feature of the blading is the method of reinforcing and protecting the tips of the blades, which is a point upon which much thought has been expended by various inventors. In forming the blades a shouldered projection is left at the tip. This is inserted in a slot punched in a shroud ring; the slots being punched by special machinery in such a way as to produce accurate spacing and at the same time form the slots so that they will give the proper angles to the blades independent of the slots in the base ring. After the blade tips are inserted in the slots in the shroud rings they are riveted over by specially arranged pneumatic machinery.

The shroud rings are channel shaped with outwardly projecting flanges which, after assembly in the turbine, are turned and bored to give the necessary working clearance. The flanges of the channels are made so thin that, although amply sufficient for stiffness, the shroud ring does not have the disadvantage of a solid shroud which acquires a dangerous temperature by friction in case of an accidental contact of the rotating and stationary parts. The use of a protecting shroud ring not only stiffens the blades, but enables the working clearance to be made smaller than in the case of naked blade tips, without danger in case of accidental contact, thus reducing the leakage loss to a minimum. The shroud also acts as a safety device, protecting the blades in case of contact between stationary and rotating members, and preventing any individual blade from working loose and causing damage.

The entire blading is produced by machinery and is made up in half rings in the blading shop and carefully inspected before being inserted in the turbine.

Fig. 2 shows the general scheme of the blading. Fig. 3 two half rings of blades ready for assembly in a turbine, these half rings being respectively the smallest and largest ones, used in a turbine of the size installed at Utica. Fig. 4 is from a photograph showing the uniformity of the blading.

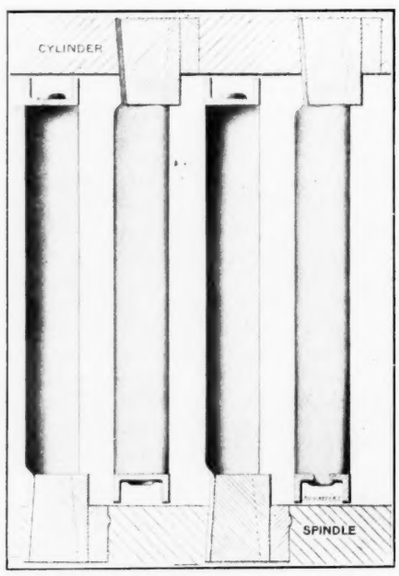


Fig. 2. Scheme of the Blading.

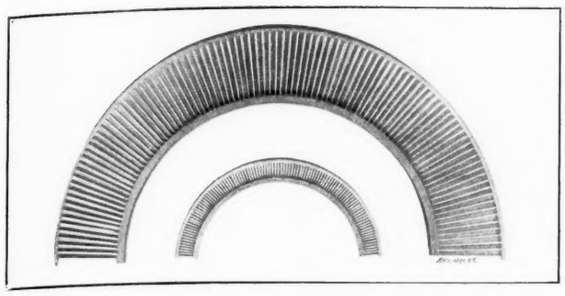


Fig. 3. Two Half-rings of Blades—the Largest and the Smallest in the Turbine.

Another special feature of this turbine will be noticed by referring to Fig. 5, *viz.*, the absence of the usual low-pressure "balance piston;" the photograph showing only two balance pistons instead of the three pistons formerly used in this type. In the Allis-Chalmers construction there is, however, a third balance piston, but instead of being at the high-pressure end, as formerly arranged, it is at the low-pressure end, and as it is smaller than the large end of the spindle it is hidden from sight in the photograph. By making this piston in such a way that its circular area is equal to the annular area of the pistons used in the older construction, the low-pressure balance piston is made much smaller. Instead of reducing the leakage past this piston by means of "dummy packing," as in the high-pressure and intermediate pistons, and as

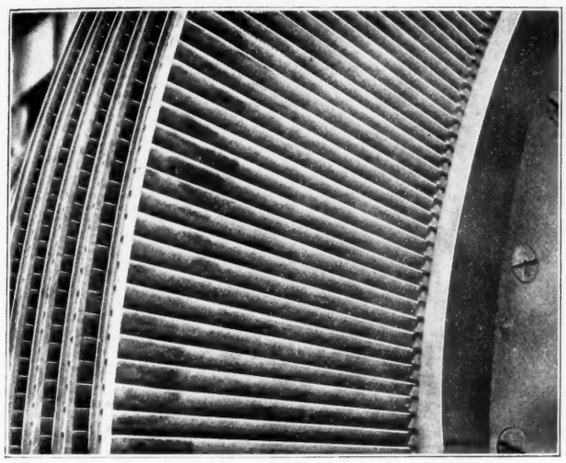


Fig. 4. From a Photograph, showing Uniformity of Bleeding.

used in the low-pressure pistons of the older construction, a labyrinth packing of radial baffling type has been adopted, thus eliminating small axial clearance in this turbine. The advantage claimed for this construction is the use of smaller working clearances in the high-pressure and intermediate balance pistons.

There are a number of other points of improvement claimed for the Allis-Chalmers construction which will not permit of description within the space of the present article. These include details of spindle construction, governing mechanism, lubrication, and other minor features.

The alternating current generator of the Utica outfit also is deserving of more description than the present article will allow. Perhaps the most noticeable feature of this generator is the substantial design of the revolving field, providing great strength and at the same time giving the thorough ventilation which is essential. Particular attention has been paid to the insulation, as may be inferred from the fact that the armature

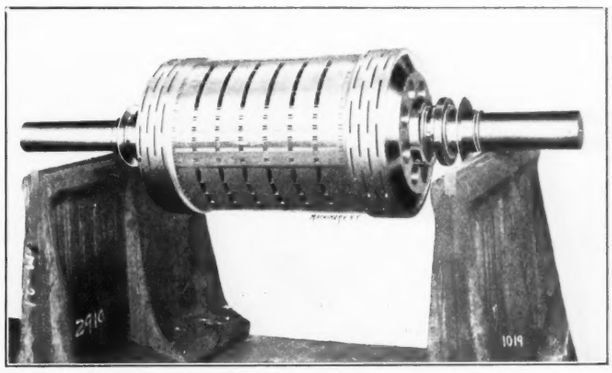


Fig. 6. Revolving Field of Generator.

(Fig. 6) was subjected to an alternating current insulation test of 10,000 volts for the period of fifteen minutes. This generator was built at the Bullock Works of the Allis-Chalmers Company at Cincinnati, where the generators for all of their other turbine outfits are being built.

The Allis-Chalmers Company, in entering the steam turbine field, effected an alliance with the Turbine Advisory Syndicate of England, including Messrs. Willans & Robinson, the high-speed engine builders, of Rugby; Yarrow & Company, the torpedo-boat builders, of the Isle of Dogs, London; and the Neptune Shipbuilding Works, Walker-on-Tyne. An agreement has more recently been effected with Hon. Charles A. Parsons, for interchange of data, thereby giving the Allis-Chalmers Company the benefit of the vast experience of Mr. Parsons, the original inventor of this type of turbine.

* * *

The *Woodworker* tells of a man who owned a mill in which the main driving wheel was located in a pit where the water collected to such an extent as to interfere with the belt, causing it to slip. He overcame the difficulty by putting some elevator buckets onto the outside of the belt, and providing means for disposing of the water as it was carried up by the buckets.

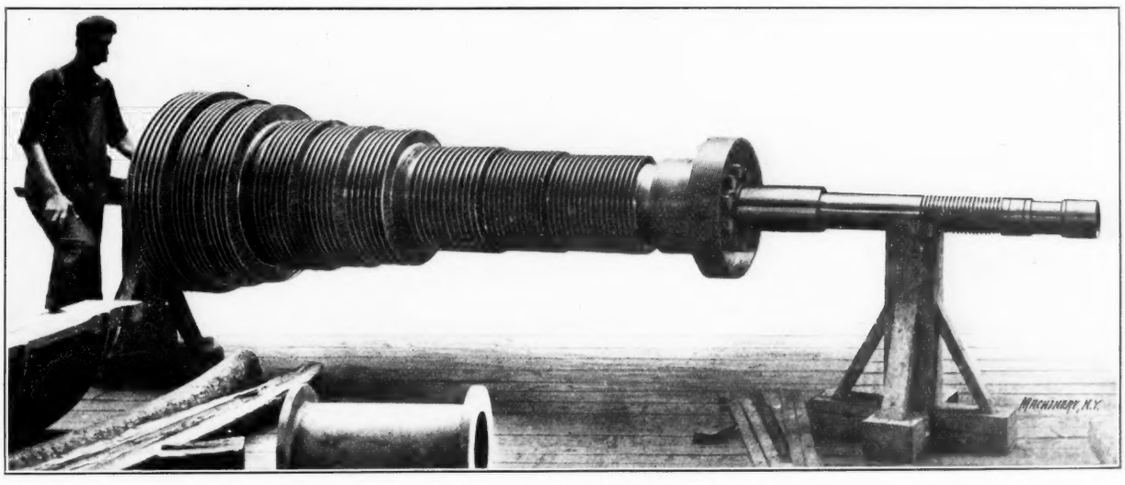


Fig. 5. View of Rotor.

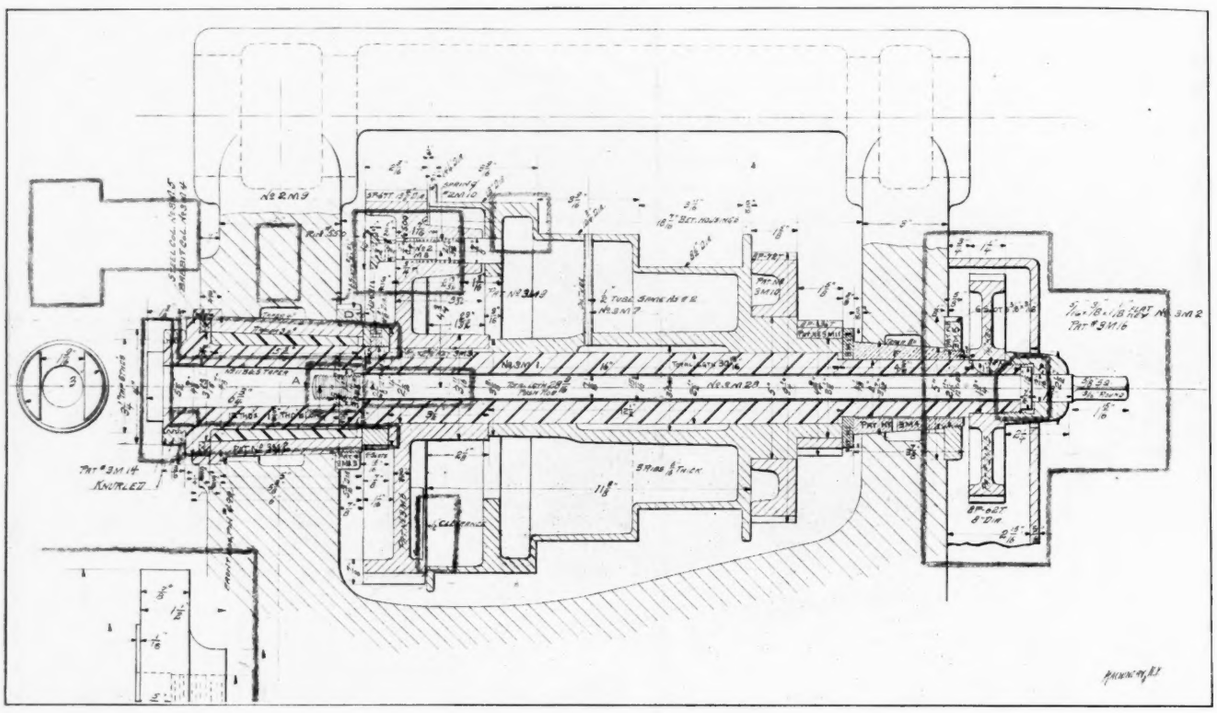
DRAFTING ROOM PRACTICE—PATCHING DRAWINGS.

W. G.

Mr. Robert Grimshaw's article on drafting-room practice in the September, 1905, issue of MACHINERY recalls to the writer his own experience along this line in the good old days when the drafting room did not bear the important relation to the shop that it does to-day; however, the time does not seem to be so long ago, after all. The bicycle industry, which was then in its infancy, and growing into the gigantic thing it afterward proved to be, leading to a demand for all kinds of machine tools, such as screw machines and automatic machines of all descriptions, gave a new impetus to the machine tool industry and also resulted in placing the drafting room on a better plane than it had previously occupied. At least that was the way in the shop that I was employed in at that time. Previous to this we had no standards of any kind for our drawings. Card indexes were unheard of, blueprints were considered too expensive and the making of tracings an unnecessary expense and waste of time. Our drawings were made any old size, and of a character that would not be considered much better than rough sketches to-day. It would have been useless to make them any greater, for they were not held in very great esteem by the shop, any way. It was considered the proper thing to use any piece of stock on hand, regardless of what the drawings called for. The only time the drawings were taken seriously was when a fellow used them to cover up a hole he got into and push the blame on the draftsman. We used a heavy drawing paper for our drawings, and when they were finished, two good coats of shellac were put on front and back and then sent into the shop.

I have used all kinds of drawing paper, tracing paper, and also cloth, and believe that we can get a more accurate drawing in less time with a good grade of bond paper, say crane or any other good bond, about No. 18; and if bought in large quantities the maker will tint this paper a soft color that is pleasing to the eye. The drawing is inked in on this paper and good blueprints can be made from it. A blueprint is kept on file for reference and the drawings are seldom used. When making a drawing upon which a great deal of time is to be spent, such as the design of a new machine, the paper is dampened and the edges are glued to the drawing board. When dry it presents a surface that is smooth and taut, and is not affected by any atmospheric changes and moisture that buckle and wrinkle any drawing paper under ordinary conditions. The boards are slightly convex or spherical and the paper is mounted over a plain blueprint which subdues the brilliancy of the paper.

But making changes on these drawings is where the great saving of time comes in over tracing cloth. The pieces or parts to be changed are cut out and a new piece is pasted in and redrawn. The draftsmen soon get so expert at this that a piece 1½ inches square can be cut out and pasted in in less time than it could be erased on tracing cloth. The piece to be changed is first squared off and cut out with a knife. This is then laid over another piece 3-32 or ⅛ inch larger than the piece that has been cut out and the edges are glued all around with ordinary library paste; it is then pasted on the reverse side of the drawing. I am sending you several drawings



Fig' 1. A Patched Bond Paper Drawing.

patched in this manner. The first is an example of our average practice, and the larger one, Fig. 1, is the worst case as far as the number of patches is concerned that I have run across. Of course the blueprint will be rather light around the edges of the patch, but this only indicates to the shop where the changes have been made.

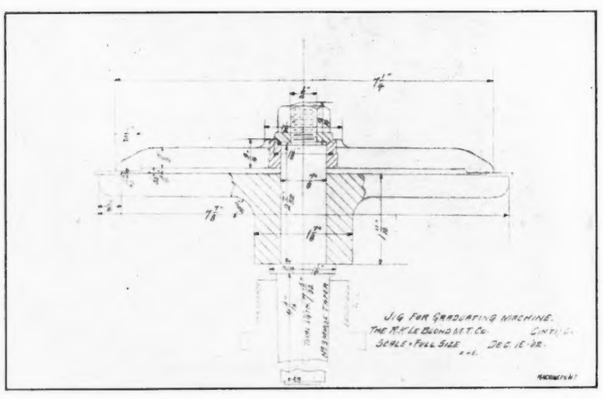


Fig. 2. Rough Sketch on Section Paper.

All records and rough sketches are made and kept on the small sheets, Fig. 2, which are about 7⅛ x 11¼ inches. We have these punched, ruled and cross-sectioned at our stationers, and while the ruling is not so accurate as on the lithographed section paper, the cost is much less, only $4 per 1,000, and it serves our purpose just as well.

What the modern drafting room is most in need of is some

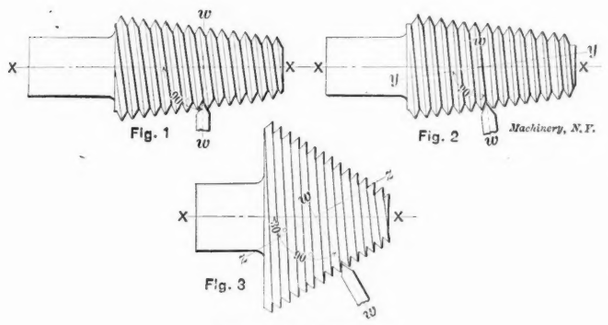
pigment for making impressions on paper that is a medium or cross between a lead pencil and the ordinary drawing ink. Something that could be used as a lead pencil, give sharp black lines, be reasonably permanent, not easily rubbed off by ordinary usage, and yet by some simple mechanical or chemical means could be quickly removed from the paper. This would do away with ink blots, spilled ink bottles, clogged pens, etc., and waiting at every few strokes of the pen for the ink to dry.

[Fig. 1 is a half-tone reproduction of a discarded drawing on bond paper which was patched in several places from time to time as changes were made. The work is so neatly done that it is scarcely discernible save when held between the eyes and the light. For this reason the patched effect would not be apparent in the cut, so we have penciled each patch around the edge, the penciling being about the same width as the lap, which is only about 1-16 inch in most cases.—EDITOR.]

* * *

TO SET A LATHE TOOL FOR THREADING A TAPER TAP.

The correct setting of a lathe thread tool for threading a taper tap such as a pipe tap, has perhaps caused as much argument among mechanics as any other machine operation, but it would not seem, in view of all that has been said and written on the subject, that there should be any doubt as to the correct setting. But, notwithstanding the fact that the correct setting has been described and illustrated in various publications, it appears there are yet men who firmly insist that the threading tool should be set at right angles to the surface of the work, as shown in Fig. 2, rather than at right angles to the axis of the tap, as indicated in Fig. 1. In this sketch, as in the others, the axis, or center line of the tap, Fig. 1, is indicated by the line *x-x* and the center line of the thread tool is *w-w*. Now, if a thread tool be set with its center line at right angles to the surface of the taper tap, Fig. 2, it will be at right angles to the line *y-y*. Where the tap has a comparatively slight amount of taper, as is the case with the standard pipe tap, the accuracy is scarcely discernible to the eye, and perhaps in some cases it will make little difference, but the method is wrong and is one that should not be persisted in.

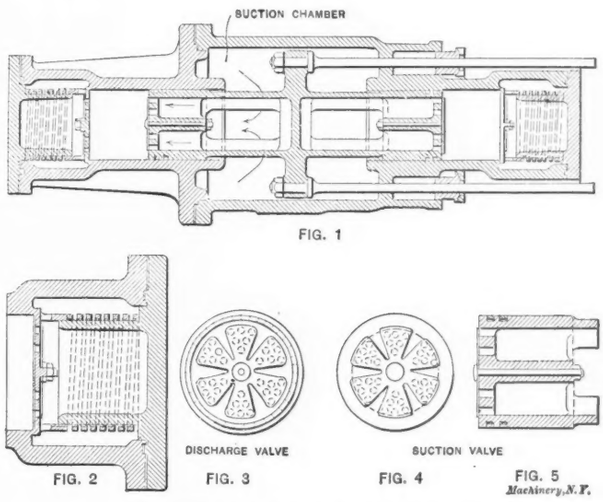


Threading a Taper Tap.

To prove that it is wrong and show the absurdity of the practice, suppose that we were making a tap having a great amount of taper. Suppose, for example, that the included angle is 60 degrees, as is the case in Fig. 3. Then, if the thread tool is set with the center line *w-w* at right angles to the surface of the work, we have a thread of which the lower side is at right angles to the axis *x-x*, instead of being at an angle of 60 degrees thereto. If the tap was of still greater included angle, the top of the thread would overlap the base, a condition which very well illustrates the foolishness of the practice. A reason perhaps for setting at right angles to the thread surface of the blank is the ease with which it can be done, using the ordinary thread gage as a setting tool, but the shank of a tap is usually turned straight, and if the thread tool is adjusted to this surface it will be correctly set. A taper tap should be threaded, if possible, in a lathe having a taper attachment, and then the conditions as laid down in the foregoing are so apparent that no room is left for argument.

AN AMMONIA COMPRESSOR WITH SMALL CLEARANCE.

A high-speed air compressor, of English make, was recently illustrated in MACHINERY, in which the principal feature of interest was the discharge valve, this being somewhat larger than the bore of the cylinder, forming, in effect an inner movable head for the bore. Its object was to give not only a large discharge opening, but to reduce the clearance space to the minimum. The same result has been obtained in a high-speed ammonia compressor built by L. Stern & Co., Glasgow, much similar in construction but with somewhat different action. The construction, as will be seen in the accompanying cuts, differs, in that the inner cylinder heads for the double-acting piston are the discharge valve seatings, but they do not lift bodily from their seats, except when the piston runs over the limits of its stroke. The discharge valves are seated on the outer faces of the heads or seatings in the usual manner, and the seating is held in place by a heavy coil spring of sufficient strength to hold it firmly in place except when the piston over-runs. The piston is connected to the piston rods by two lugs attached to the sides and these lugs work in the suction chamber which surrounds the center of the piston. The incoming ammonia gas passes from the suction chamber through large openings in the sides of the piston and from thence out through the small openings in the ends of the pistons, which are covered by light metallic plates, forming the suction valve, as shown in Figs. 4 and 5. The clearance spaces are reduced to nearly zero and the length of the connecting-rod is adjusted so that normally the valve seatings at the ends of the stroke are not disturbed. The compressor may be run at high speed economically and without fear of damage, for in case the adjustment is lost the knocking will at once warn the engineer without causing a smash-up. An advantage of the design is that the piston rods are not subjected to great variations in temperature and the piston rod glands do not work against high pressure, thus reducing leakage and the friction losses of the machine.



An Ammonia Compressor with Small Clearance.

* * *

It is said that tantalum has great possibilities when used for tool making, its toughness and hardness rivalling the diamond. Von Bolton made a laboratory experiment recently, when a sheet 0.04 inch was hammered from the first piece produced of the pure metal, and all attempts to drill a hole through it were found to be futile. Finally a diamond drill was employed, and after continuous work for seventy hours at a speed of 5,000 revolutions per minute, about one-fourth of the task had been completed, while the drill was so badly worn as to necessitate a discontinuance of the test. Tantalum is entirely non-magnetic, has a specific gravity varying from 14 to 17, and fuses at about 2,300 degrees C. (4,172 degrees F.). In the form of a wire it has a tensile strength of about 128,000 pounds per square inch.—*Mechanical World.*

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a specialedition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

We think the readers of this month's Engineering Edition will not be sorry that we have stepped outside the realm of mechanics sufficiently to give space to an article upon the subject of selling machine tools. It is said that it is easy enough to make a machine, but another matter to sell it. This, of course, is not strictly true, because occasionally a mechanic is bright enough or fortunate enough to hit upon an idea which, when worked out in iron and steel, will produce a machine that will sell itself. The number of instances where this has occurred, however, are few and it is the selling end of the business that usually must receive the greatest share of attention. In fact, so important is the commercial side of engineering becoming, that it begins to look as though no mechanical man could make an unqualified success, from a financial standpoint, unless he be more or less of a "commercial engineer"; that is, a man who, while versed in the science of mechanics and the art of machine construction, is also accomplished in the business of distributing the products after they are completed. Unquestionably the strongest combination that a man of ability can have is a full knowledge of the two branches of the business.

* * *

A correspondent has called our attention to a few errors which appear in past issues of MACHINERY data sheets and has intimated that such errors are inexcusable. It is true that there is no excuse for errors in matter of this character, but they *occur*, nevertheless, and it seems practically impossible for the editors of this publication to check all calculations that are necessary in the preparation of some of the data sheets published. We are dependent, to an extent, upon the accuracy of our contributors; the matter of correct proofreading rests with us, but surprising errors sometimes occur by the simple transposition of two lines, an error which is very easily made in linotype composition, and the omission of a single word will sometimes change the sense entirely. For example, in the August, 1904, sheet, the omission of the factor 1,000 gives a ridiculous result to the rule for finding the safe load for chains; for a one-inch chain it gives the working load as 16 pounds, whereas the factor 1,000, which was omitted, would make it 16,000 pounds. When it is considered that the elimination of errors from textbooks and handbooks, which are very carefully compiled and in which the factor of time is not so important as in the publication of a periodical, is a matter of years there appears to be some faint shadow of extenuation to offer. Kent's Mechanical Engineer's Pocketbook was published in 1895, but the author admits that the errors in the orginal are not all eliminated yet, notwithstanding that it has been for some years in the hands of thousands of draftsmen and designers who constantly refer to it.

* * *

EDUCATION OF FOREMEN.

The first article in the Engineering Edition of last month, by O. M. Becker, outlined some of the important reasons why more attention should be given to what he terms factory education, particularly for men who are to hold important machine-shop positions. In the current number he presents a description of one notable attempt in this direction.

The need for this becomes even more apparent when we consider the tendency of the technical schools, or at least some of them. They are not offering the opportunities that they should for this intermediate or foreman class of men. The schools are crowded and there is a constant call for instruction in a wider diversity of subjects, which means increased expense. One result of this is a tendency to raise the rates of tuition, as can be instanced in one case, where tuition is now $250 per year—almost a prohibitive sum. These schools, also, are constantly raising the requirements for entrance and call for preparation in perhaps two foreign languages, advanced algebra, trigonometry, etc. The result is that students in moderate circumstances, who have not been able to take the necessary preliminary training, will think twice before attempting a technical course. We are aware that many such institutions and some others are not conducted along the lines indicated and we will ask those interested in them not to rise and say that we have misrepresented the conditions. We are pointing out a tendency, merely, and that tendency is such as to indicate that men who are to hold responsible intermediate positions in our machine shops must look elsewhere than in the technical schools or even than in the machine shop itself to secure the training they require.

* * *

THE CARMANIA.

The arrival on December 11 of the *Carmania*, the new turbine trans-Atlantic liner of the Cunard Line, is one of the events in mechanical progress that will be recorded in industrial history. The *Carmania* is a sister ship to the *Caronia*, one of the largest and latest of the Cunarders, but fitted with reciprocating engines instead of turbines. There is thus afforded an opportunity for direct comparison between the performance of two great ocean liners having the different methods of propulsion. Singularly enough, on the day the *Carmania* arrived there were in the port of New York two examples representing the highest development of the old and new in marine machinery. There was the turbine-driven *Carmania* and the engine-driven *Kaiser Wilhelm II.*, with 44,000 horse power of reciprocating engines on board. Does the latter represent the last great example of the marine reciprocating engine that will be produced? The success or failure of the *Carmania* will in a large measure answer this question.

The difficulties that have had to be overcome in producing a turbine ship of the immense proportions of the *Carmania* can scarcely be appreciated. The turbine is essentially a one-speed machine, and does not give good economy at other than the speed at which it is designed to run. It is also a high-speed machine and it has not been easy to design propellers that would give good results at these high speeds. The reaction turbine, which so far has been used almost entirely in marine work, and is well adapted for this purpose because of the thrust exerted in this type which can be used to balance the thrust of the propeller, is also a complex machine, as is evident from the fact that the turbines of the *Carmania* have 1,250,000 blades. Any distorting of the casing or elongation or displacement of the blades, that should cause the rotating elements of the machine to come in contact with the stationary elements, would prove disastrous and provision must be made against such a contingency. These and other difficulties are serious ones, but not insurmountable, and the marine turbine now seems to have reached the critical point in its development and engineers will await with intense interest the result of this gigantic experiment on the part of the Cunard Company.

PATENTS IN THEIR RELATION TO THE GAS ENGINE AND THE AUTOMOBILE.—1.

S. M. HOWELL.

Fortunately for the progress of the gas engine art, there are no basic patents now in force upon the internal combustion motor, its essential features having been developed many years ago. And yet it is certainly true that gas and liquid-fuel engines have in recent years undergone certain very radical changes in form and dimensions. But these changes are practical developments rather than patentable inventions, having resulted chiefly from the efforts and experience of many designers, whose object it was to reduce weight and simplify construction in order to produce a suitable motive power for the automobile. The result of this has been the general adoption, by common consent, of certain simplied forms of gas engine construction, identical in operative principle with the systems devised by the early experimenters, but reduced greatly in weight, remodeled in proportions, and adapted to higher speeds and the development of greater power. Although the records of the United States patent office show about six hundred and seventy patents classified as "air and gas engines," it is apparently a fact that what may be termed the standard types of automobile and other gas engines are not within the limits of patent restriction. The plain two-and-four-cycle systems in their most simple forms have gained the favor of popular approval, in spite of the best efforts of invention to supersede them. This is no doubt due largely to a general disposition on the part of the manufacturers and users, to reduce the question of small motive power to its simplest terms, by means of an engine of few parts and easy construction. Gas engine patents are usually additions to the original structure, and would naturally be avoided in a design which had for its object the simplification of the machine.

The study of patent office records in order to trace the history of the gas engine and determine the origin of any given form of these motors, is an intricate and somewhat difficult problem. This is principally, of course, owing to the immense number of such patents, but partly also to the fact that many of them are contradictory and often claim and repeat identically the same thing. And moreover patent office classifications are somewhat incomplete, there being no separate divisions of the indices to correspond with the subclasses of the patents, and the definitions given to the various subclasses are so brief as to be often incomprehensible and entirely inadequate. It is true the office has published a number of bulletins which remedy this defect to some extent by outlining the general character of inventions included in certain subclasses, but this has not yet been extended to the subject of engines, and it is therefore necessary, in order to determine the status of any given case in regard to priority, to go over the entire index of the whole number of patents granted. The writer has given much time to this subject and believes that by dint of effort he has, at least for the purpose of this article, succeeded in reducing the matter to manageable proportions.

The origin of the four-cycle system goes back as far at least as the Otto patents of 1877. The principle, however, underlying the operation of the Otto engine and the four-cycle system as now used, was first worked out and proposed by Beau de Rochas, a French engineer, in 1862. These engines were the first really successful internal combustion motors ever built. They were of great weight and of monstrous proportions, and intended only for stationary purposes. This engine was the first to use a compressed charge, and although its method of ignition, sliding valves and other mechanical arrangements are now obsolete, its operative principle is still the basis of all modern practice in four-cycle engines.

The modern four-cycle automobile engine, as regards its general features, sometimes called the De Dion pattern, comes from the Daimler patent of 1886. This is especially true of that very common style in which the flywheels are disks inclosed within the crank case. Part of this type of construction, however—that is, the tight crank case—originated in a still earlier invention by L. H. Nash in 1883. In this engine the crank case contained oil for splash lubrication.

The two-cycle engine working a compressed charge was first proposed in the Robson patent of 1881. The Robson engine had a double-acting cylinder, the front end of which was used for previous or preliminary compression. The firing was by means of a jump spark coil and a magneto, driven by the engine. The cylinder was provided with valves through which the exhaust escaped and the fresh charge entered simultaneously. The charge was finally compressed on the back stroke and fired at each revolution, thus constituting so far a two-cycle compression engine. But the other feature of the modern machine, *viz.*, the inclosed crank case, had not yet been developed. This patent was followed by the Benz, and several others on similar lines until 1891, when the English patent of J. Day appeared.

This patent is in all essential respects the prototype of the modern two-cycle engine, as now generally used for automobile and motor boat propulsion, consisting of an inclosed crank case and a cylinder without valves, but provided with two ports, so situated as to be uncovered by the piston during the terminal part of its outstroke, the crank case being utilized as a pump for previous compressions, and being placed in communication with the cylinder by means of a transfer passage. The appearance of this invention marked a new era in two-cycle engine construction, and scores of patents followed it, all built on similar lines, but modified in various ways as suggested by different designers. Unfortunately for the inventor of this engine, the patent seems to have no legal force in the United States. I have made considerable effort to discover the reason for this, but so far without success. It is quite likely that the patent is void in the United States for the reason that the application was too long delayed, not having been filed here until 1894. There is a law that a foreign patent granted upon an application made more than one

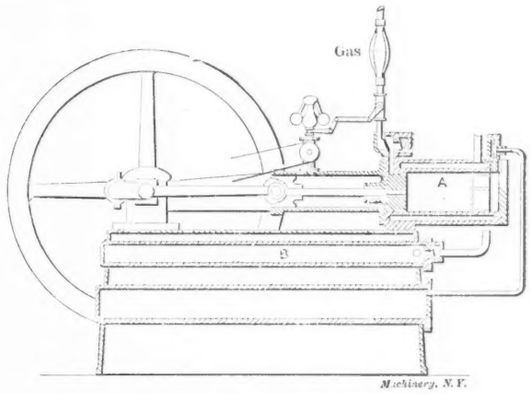

Fig. 1. Engine using Compressed Charge, Robson Patent.

year prior to the date upon which the application is made here, will act as a bar to the grant of a United States patent. And although the patent was secured, it would seem to have been issued contrary to law, and is therefore void. Quite a number of American manufacturers have been building these engines for several years, apparently without protest, and seem to regard it as a dead letter.

The Robson patent mentioned above as the first instance of a two-cycle engine using a compressed charge, is sufficiently shown here by Fig. 1. The cylinder is double acting, and the piston rod is supported by a crosshead as in steam engine practice. The front end of this cylinder is the air pump for preliminary compressing. There is a reservoir *B* in which the slightly compressed mixture of air and gas is stored, and delivered to the rear or power end of the cylinder, immediately after the exhaust, at the termination of each out stroke. The Benz patent, Figs. 2 and 3, is the same in principle as the foregoing, except that the engine stored and compressed pure air only, the gas being forced into the cylinder during the *last* half of the *compression* stroke by means of a gas pump driven from the crosshead, shown at *G* in Fig. 2. The inventor says in his specifications that this primary separation of the air and gas was effected to prevent the escape of the fresh gas through the exhaust valve. But if he had made a slight change in the adjustment of his gas pump, so as to admit the gas during the *first* half of the *power* stroke, he would virtual-

ly have made what we now know as the Diesel engine. This, however, will be discussed more at length in a future paper. In Fig. 3, *E* is a hollow bed plate in which the air is stored at a slight pressure by the action of the piston in the front end of the cylinder, as in the Robson engine, and *I*, in Fig. 2, is the valve through which the gas is driven into the cylinder by the gas pump *G*. The double-acting cylinder type in which the

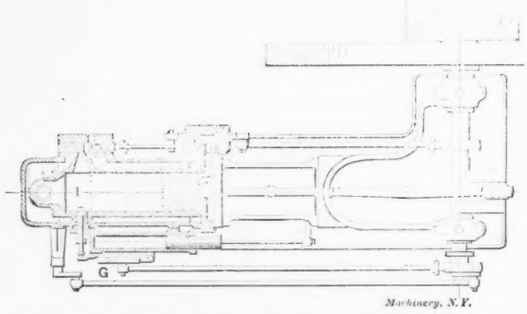

Fig. 2. Horizontal Section of Benz Engine, showing Gas Pump

front end is employed for preliminary compression, was once a great favorite with gas engine inventors, but has since been abandoned in favor of the inclosed crank case.

The L. H. Nash patent is illustrated here by Figs. 4 and 5. This patent embodies four important points, and furnishes an expired precedent for the following features: The inclosed crank case, air-jacketed cylinder and protected piston and

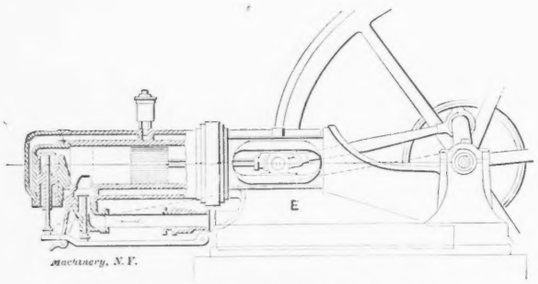

Fig. 3. Vertical Section through Benz Gas Engine.

splash lubrication, with a mixture of oil and water. In lieu of a jacket, the crank case of this engine has an upward extension which incloses the entire cylinder, leaving an annular space around it.

The bottom of the case forms a tank for the oil and water which is splashed about by the motion of the crank, lubricating the interior parts and being carried along to some extent

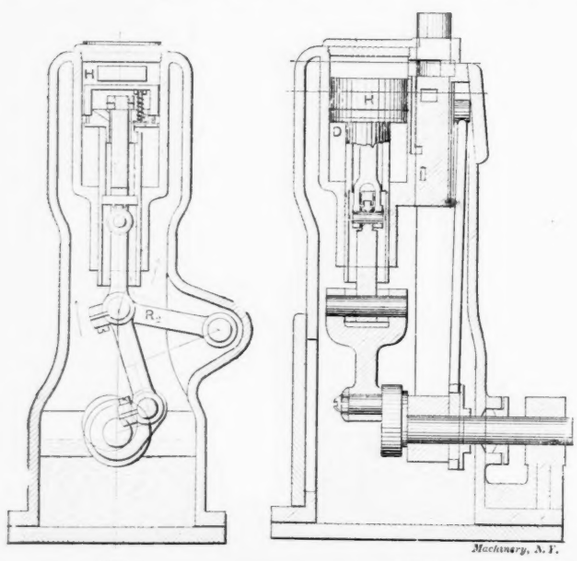

Fig. 4. Fig. 5.

Fig. 4. Cross-section, and Fig. 5, Transverse Section of Nash Gas Engine.

also with the entering charge, and oiling the cylinder. The fresh air being constantly drawn into the crank case by the pumping action of the piston, circulates around the cylinder and forms the principal dependence for cooling, though in some cases assisted by the injection of a small amount of water. In regard to the piston, it may be noticed that the thick cap or protecting piece, *H*, is slightly smaller in diameter than the cylinder bore, and does not come into actual contact with the walls of the same. By reason of this cap or extension, the greatest heat is confined to the upper part of the cylinder, the ring *D*, working in the lower part where the walls are not exposed to the impingement of the flame, and are therefore somewhat cooler. This ring, too, is said to be made of a refractory material. This feature of the extended piston was subsequently more fully developed, and very successfully used in an engine which we will discuss at another time. The rod or link R_2 in this patent is a substitute for a crosshead, a device now entirely unnecessary. The engine was four cycle.

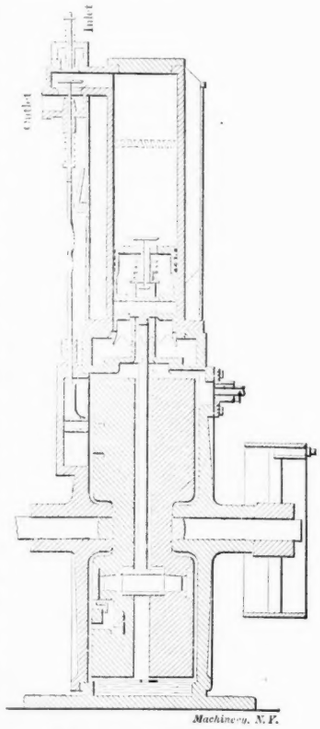

Fig. 6. The Daimler Engine.

The Daimler patent is illustrated by Fig. 6. This famous invention contains several individual features, but is shown here only for the reason that it was the first instance in which the fly wheels were inclosed within the crank case, a method of construction which was followed up in France, and has become very popular here with builders of small automobile engines. It may be noted, also, that this engine used an ignition device which was equivalent to the now well-known hot tube, and seems to be the pioneer in this system of firing the charge. Pure air or a weak mixture was drawn into the crank case and admitted to the cylinder through a valve in the piston, the gas being drawn in separately. The object was to avoid preignition.

The Day patent, previously mentioned as being the first to use the closed crank-chamber as a compression cylinder, will be described among the patents reviewed in the next installment of this article.

* * *

The welfare work done by the National Cash Register Co.- Dayton, Ohio, is well known. For a number of years they have made it a practice to furnish a noon-day lunch to all their female workers, numbering between 500 and 600. The latest move is to build an enormous eating hall 100 feet wide and 328 feet long, which will accommodate 4,000 persons at luncheon at once. This building can also be used as an auditorium, in which capacity it will seat an audience of 6,000. This combined dining and lecture hall will be managed by the Men's Welfare League, an organization of workingmen of Dayton. It is expected that luncheons will be served to at least 3,000 people per day. The furniture and dishes are supplied by the company, and the league hires the help, purchases the supplies and serves the meals. Luncheons will be served for 15 cents each or 90 cents per week. This apparently is a move on the part of the company to relax something of its paternal attitude while at the same time to extending its welfare work. The men will manage the business themselves, and thus will not feel so much that they are the beneficiaries of a charitable provision.

HOW MACHINE TOOLS ARE SOLD.

A conversation between Mr. H. F. Frevert and the Publisher of MACHINERY that makes interesting reading. Mr. Frevert has had many years experience of trade conditions on both sides of the Atlantic, as Sales Manager for some of our largest manufacturers.

Q. Have conditions connected with the selling of machine tools changed during recent years? A. Not to any extent. Some years ago it was generally considered that the dealer or middleman was a necessary evil and in time could be eliminated, and many even thought that his days were numbered; but as the manufacturers of machine tools are more and more becoming specialists, confining themselves to the manufacture of one, or at least a few kinds of machines, it appears that they are more than ever before dependent on the dealer to aid them in marketing their product, and the manufacturers seem now to appreciate this, for they protect their dealers more than ever and in every way they can, by referring all inquiries and orders to the dealers representing them, and doing all they can to prevent one from encroaching on another's territory, going so far as refusing to ship machines sold by one dealer into another's territory, although this sometimes brings about curious complications. For instance, many of the larger buyers have factories in different states, with their main office in New York, where the buying is done, and although the order may be placed with a New York dealer the factory will not ship the machine if the point of delivery is in another dealer's territory. In a case of this kind the New York dealer usually explains matters to the factory and divides his commission with the dealer into whose territory the machine is shipped, and this is generally satisfactory. The New York dealer could of course have the machine shipped to New York or some point in his territory and then reshipped to his customer, and this is sometimes done, although the difference in the freight may not amount to as much as he would have to divide with the other dealer. This is considered "sharp practice" and not often resorted to by the best dealers and is not countenanced by the manufacturers.

Q. What about the cost of selling compared to that in other trades? A. Probably the most difficult problem the average machine tool manufacturer has to solve is the sale of his product at an expense that will leave him a fair profit. In almost every business the greatest expense is for getting in touch with the buyer—getting his confidence and booking his first order. After that, the subsequent orders are secured with comparatively little effort and expense, provided of course the article sold is satisfactory; but in the machinery business, with the exception of the railroad companies and a comparatively few large and growing manufacturers using metal-working tools, the majority of buyers are new customers, and after buying their first installation or outfit of machinery they may not require any new or additional tools for years. This is the case with the various mills and factories, who purchase a few tools to keep their own machinery in repair; and the average machine shop or manufacturer of articles requiring metal-working tools, unless they meet with unusual success and increase rapidly, buy a new machine only now and then, but not frequently enough to justify the manufacturer in keeping a representative in personal touch with them. This is partly due to the long life of machine tools, usually estimated at from twenty to twenty-five years.

Q. How important a factor is the work of a traveling salesman? A. A very important factor, I should say. In most mercantile lines manufacturers can and do keep traveling salesmen who visit at regular intervals not only the larger cities, but small towns as well, and find in each a number of jobbers or merchants dealing in their respective lines; but only in the larger cities will be found a machinery merchant, and those cities are few and far apart, making traveling between them expensive. There are very few, if any, manufacturers of machine tools in the United States who keep, or could afford to keep, traveling salesmen constantly on the road doing so-called missionary work; but most of them have traveling salesmen whom they send out on special inquiries. This is not surprising when we remember the long life of machine tools and that they are not consumed in the sense that pig iron, steel and other materials are. While it is true that there are machine shops and metal goods manufacturers in nearly all the large towns east of the Mississippi River, and also of course on the Pacific coast, a traveling salesman could not earn expenses for a manufacturer making only, say, shapers. He might visit a number of towns and not find a single shop then wanting a shaper, although a number of those called on might be in the market for a planer, a drill press or some other machine which his employer does not make.

Q. This, I judge, is where the local dealer steps in? A. Yes, and where he is of great assistance to the manufacturer; for although the dealer has but a small margin of profit compared to the manufacturer he can, in his limited territory, and with a variety of tools of different makes, and usually a line of supplies to sell, keep his traveling salesmen at less expense in contact with every buyer, with a very much better chance of securing an order for some kind of a machine or supplies than could the manufacturer's salesman who has but one kind of a machine to offer.

Q. What is the usual method followed by the average manufacturer to obtain business? A. To advertise in leading trade papers, to send out circulars and catalogues, and to arrange with some machinery dealer to represent him exclusively in the latter's territory, usually within a radius of three or four hundred miles. While this is no doubt the best arrangement that has been tried, it is not always satisfactory for several reasons. The dealer, especially in the smaller cities, may have the agency for two or more manufacturers of the same kind of tools, and in that case one or the other manufacturer is sure to feel that he is not getting the amount of business he feels he is entitled to, and there is no doubt that the machine having the greatest number of talking points, or the one that is advertised the most, or that is sold for the least money, is the one that is easiest to sell and has the greatest sale, for the salesman invariably takes the line of least resistance and will sell the machine for which his customer shows a preference, and the average salesman is not slow to note and fall in with the views of the buyer. The very fact that machinery dealers are required to sell a great variety of tools prevents them or their salesmen from being familiar with all the working details and the advantages of certain parts of the different machines and it is no doubt true that there are many tools sold daily that are not the best for the kind of work for which they are purchased. The salesman can hardly be an expert in these matters, although it would be to his advantage if he were; but it is surprising how little the average salesman knows in a mechanical way about the machines he sells. He usually gets hold of the "talking points" his machine has over others and talks them the best he knows how.

Q. Is there much cutting in prices done by dealers? A. Prices are usually maintained by dealers on machines for which they have the exclusive agency, except when bidding for the United States government orders or on large railroad or other equipments, in which cases a lump sum bid is usually made and prices cut considerably, frequently by the manufacturer making a special price for the occasion, and still further by the dealer cutting his commission. There is always more or less cutting of prices on machines that are in the open market; that is, machines for which there is no established agency, but that can be bought and sold by any dealer.

Q. When a customer calls at a store does he usually insist on buying some particular make of tool, or is it easy to switch him off on another make for which the dealer is the agent? A. Customers for machine tools are not different from the rest of human kind. Some know exactly what they want and insist on having it, while others can be influenced to buy what the seller has to offer. The majority of tool buyers are willing to listen to and investigate the claims of advantage made for different tools, and it depends entirely upon the salesman's ability to convince the customer that his machine is superior to others. If he can do so he usually secures the order, and it may be at a higher price than his competitor's. The average buyer, if convinced that a certain machine is superior or is better adapted for doing his particular class of work, will not let the matter of price stand in the way of obtaining it.

Q. What is the proportion of sales compared to the number of inquiries, or the number of quotations made? A. If you refer to quotations made by letter that are not followed by a personal interview with a salesman, the proportion of sales to the number of quotations is very small indeed, some estimates being placed as low as 10 per cent. A well-known machine tool manufacturer who was considered one of the smartest in the business, said some time ago he considered it time wasted to simply make a quotation by letter and not follow the quotation by sending a salesman to see the prospective buyer, and he usually consigned such inquiries to the waste basket. This shows how differently men feel about the best means of getting business. There is one of the New York machinery houses that depends almost entirely on the mail for their orders, although I understand their policy is to cut prices, which they can afford to do, as they save the expense of salesmen and traveling. By this means they get the reputation of selling goods cheap, and do a large volume of business, much of their business coming to them simply on account of this reputation.

Q. Where they get such a small percentage they of course do not handle the tools? A. There is probably not more than 25 per cent of the tools sold that are shipped from the store or warehouse of the dealer. Three quarters of them are shipped directly from the factories and are never seen by the dealer making the sale.

Q. Isn't a purchaser more likely to buy from a dealer than from a manufacturer, knowing that if there is anything wrong with the machine he is more sure of having it made right." A. Yes, most buyers prefer to purchase from the dealer, and why should they not? The dealer sells as low as the manufacturer, and often lower by cutting his commission, and will give better terms, while the manufacturer guarantees his machines whether bought direct or through a dealer, so the buyer has a double guarantee when buying from a dealer; and if anything is wrong he has the dealer to stand between him and the manufacturer and fight his battle for him. It is to the dealer's interest to have the matter adjusted to his customer's satisfaction, and the former is in a stronger position to force his claims (if need be) with the manufacturer than is the individual buyer.

Q. Isn't there quite a large profit on second-hand tools? A. It depends altogether on the buyer, his experience and knowledge of values and which tools are salable or not. When the country is prosperous and business good, there are but few second-hand tools to be had, nor is the demand for them as great as when business is dull—then the supply is increased by failures in business and by factories getting rid of tools they have no further use for. The demand then is also greater, no doubt because the buyers don't feel prosperous and want to save every dollar they can.

Q. Are many new tools sold and part payment taken in second-hands? A. Very often.

Q. If a concern wants to buy a large tool that will, for instance, replace a lot of lathes, doesn't the dealer often have to take those lathes in part payment? A. That is often the case.

Q. And for that reason isn't it more difficult for a manufacturer to market his product because a dealer can take such tools in part payment, having a market for them; whereas, the manufacturer has no way of disposing of them. In fact, he wouldn't know what they were worth? A. Yes, there are few, if any, manufacturers, who will take second-hand tools in exchange for new ones. They have no means of marketing them. This, again, is where the dealer is of great assistance to the manufacturer.

Q. How is advance information acquired of the building of new shops and the requirements of manufacturers in general? Is there any systematic effort to get that information made by concerns who have salesmen on the road? A. Such information is usually obtained in a number of ways. Very often from the trade papers and through the dealer's friends in the trade; but more often from the inquiries that come in direct to concerns who advertise.

Q. But wouldn't it pay a dealer to have his men stay long enough in each place to collect information in regard to anything new—I mean to do it systematically? A. They very often do that, and a bright salesman will always inquire in every town he is in regarding new enterprises or factories, and will call and keep track of them, but beyond this and writing letters and sending circulars to various new companies mentioned in the trade papers, I do not know of any systematic effort made by any house to collect information.

Q. What about the number of salesmen employed in the larger houses here? A. Compared with other commercial lines there are not a great many. I don't think there is any machinery house that has more than six or eight salesmen in any one city.

Q. What about selling railway shop tools? A. When railways are in the market they usually send out a list of machines wanted to the different dealers and manufacturers and ask for bids.

Q. Government work the same? A. Yes.

Q. Why is it that some concerns can sell so much more to railways and government shops than others? Why is it that manufacturers generally cannot? A. The railway companies usually prefer to place their orders with one concern for the complete outfit, and as only the larger houses are in a position to carry these large accounts they make the greater efforts to obtain and hold the railroad trade. Such houses can afford to book a large order at a smaller margin of profit than can the average dealer or individual manufacturer who has only a few of the tools to sell.

Q. Isn't government and railway trade considered very desirable by a good many people? A. I don't believe the government trade is considered by many to be worth the trouble it takes to get. They usually have to cut prices so there isn't much profit in it, and wait a long time for payment; and the government is very strict in its requirements. In the first place it is considerable trouble to make out the bids and furnish bonds, and the tools have to be delivered within a given time. If they do not arrive within the time specified, the government charges one fifth of one per cent of the amount bid for each day's delay, although the delay may be the fault of the transportation company or causes over which the dealer has no control.

Q. Does entertaining amount to much in railway sales? A. Yes, it does with some people, and there is more or less of it done.

Q. There must be many purchasing agents who won't accept favors of this kind? A. It isn't always the purchasing agent who is the one to reckon with; it is very often the master mechanic, the superintendent, or the man into whose hands the tool finally comes. The master mechanic or superintendent is the one who sends in the requisitions to the purchasing agent for the tools he wants.

Q. Is the sending out of circulars an important factor in the dealer's advertising scheme? Does any one send out circulars systematically? A. Yes, they all do.

Q. A good many send out second-hand lists? A. Most of them, but not at stated intervals. They are sent out spasmodically, depending on the stock on hand.

Q. If dealers have an inquiry for a tool do they try to work a second-hand off? A. As a rule they do not offer a second-hand tool if a new one is asked for, provided they have a new one to offer.

Q. Isn't it exceedingly difficult to get good machinery salesmen? A. Yes.

Q. What does their pay average; minimum and maximum? A. I know salesmen who work for $15 a week; the average is probably $1,800 per year. I know one salesman who made $17,000 a year. The salary depends altogether on the amount of goods a man can sell.

Q. Do they usually work on salary or commission? A. Lower priced salesmen generally on salary. The $17,000 man worked on a salary and commission. It depends largely on the class of tools; on the large tools the percentage of commission is small, but the sales run into large amounts.

Q. How do manufacturers of special machines market their product? A. Most of them have their own travelers who cover the country thoroughly, and solicit and sell direct to the user.

Q. Why does this pay such manufacturers when it wouldn't pay the ordinary machine tool builder? A. For the reason

that special tools are sold at higher prices, for it costs the manufacturer more to sell them than when sold through dealers; but this is taken into account and the selling price is fixed accordingly. These special tools require trained men who are able to demonstrate just what the machines will do, and they cannot depend on the dealers to dispose of them.

Q. Is it customary to send men out to operate a machine tool? A. Not except in the case of special machines, and I think there are only a few manufacturers in the tool line who send men out without charge to instruct the operators how to obtain the best results.

Q. Does that pay, in your opinion? A. I think it is money well spent. For instance, a large concern in Pennsylvania bought two special machines. They were asked if they wanted an instructor at $3.50 per day and expenses, and they said: No; they had capable men who could run them. They set the machines up all right and then wrote that one wasn't doing satisfactory work of a certain class, and wanted to know what to do about it. The manufacturer replied that the machines were all right, and suggested that possibly the operator wasn't familiar with that kind of work, and offered to send a man there to give them instruction. They said they didn't feel like paying $3.50 a day and expenses, but the manufacturer happened to have a man coming home from the West and told him to stop over for a day or two and give them instructions, which made everything all right. Now, if they had refused to let that man go there (they wouldn't have sent for him), that machine probably never would have been satisfactory on that kind of work, and they would have blamed the machine. One company I know will send a man at their own expense with their machine to any place in the United States to stay with the new operator a week, or as long as necessary; and it's money well spent, because the operators get to know the best the machine will do. Then, too, the maker's representative can show the maximum that can be done on the machine, and that puts it up to the workman himself to get as much out of the machine, so when there is another machine needed the same manufacturer is sure to get the order. It is better to charge this right into the price of the machine and send a man.

Q. Then, don't you come right up against competition and find the price is too high, compared with manufacturers who don't do that? A. The matter of price doesn't count if you have talking points which will convince a purchaser and demonstrate that the machine is better than any other he can buy, and that he will get more for his money.

Q. Is a dealer often called on to furnish an estimate for the complete equipment of a shop, and asked to advise the customer what he ought to have, or does the customer usually hand out the list and say, "I want a price on this"; because a dealer ought to be able through his experience to save a customer a lot of money? A. Yes, he is often asked to estimate on a complete equipment, but not for advice as to what ought to be bought; because a buyer usually has his own mechanical man if he himself is not a mechanic, and he is so familiar with the work he is going to do that he usually decides on the machines he wants, and a great many salesmen often lose an order by trying to tell a mechanic that he ought to have a certain kind of a machine for a job. We all think we know our business best, and if one tells a man that isn't the machine he wants, but that he needs so and so, he takes it as a reflection on his intelligence. He generally thinks he knows better than the salesman.

Q. But he is not so likely to be familiar with the latest types of machines for doing certain work as a salesman is; and wouldn't the latter be qualified to offer advice that would be of value to the buyer? A. He ought to, but I don't believe the majority of salesmen are practical men, and where they sell such a variety of tools they can't become familiar with the details of each machine, as can the representative of the concern that makes that particular machine a study. That is where the firm I referred to has the advantage. They send out men that sell that one machine and nothing else. They are trained and practical men who can take a piece of work and figure out the time it would take to finish that piece in almost any shape you want it. That is something the ordinary salesman can't do.

Q. Is the social factor important in business—treating, etc. A. I think it is, but not as much as it used to be; not as important as most young salesmen imagine it is. I think they blow in a great deal more than is necessary.

Q. It is said of a large Eastern concern noted for their conservatism that when a reduction has been made in the price of one of their tools, they send a check for the difference to every customer who has bought one of those tools within thirty days. Is this a fact? A. Yes, I have been told so. I have had men say to me that they felt perfectly safe in ordering a machine from the concern referred to without asking the price, and I don't know any other concern in the United States that bears this reputation, although there are doubtless others that are entitled to it.

Q. Is there much difference in the price between the standard machine tools of the different makes? A. Very little. For instance, on 14-inch lathes, I don't believe the price on any of them will vary more than ten or fifteen per cent, leaving out two or three high-priced ones who get about one-third more than other manufacturers do.

Q. To what extent is the purchase of a tool influenced by the practical man in the shop? A. Usually the practical man decides what tool is to be bought. Most buyers leave that to the mechanical man. Certainly any wise one would.

Q. To what extent do features like gear drives, feed boxes, etc., assist in selling tools? A. They assist very materially; they are talking points, and the more you get of them, whether valuable or not, the easier it is to sell. You want talking points.

* * *

TURBINE BLADES.

In a paper on the construction of turbines read to the Institution of Engineers and Shipbuilders in Scotland recently by Mr. E. M. Speakman, it was stated that the material of which blades are usually made is a mixture of cheap brass containing 16 per cent of copper and 3 per cent of tin. Alloys containing zinc are extremely unreliable for high temperatures, but blades containing about 98 per cent of copper have been found very satisfactory for use with high superheats. More recently a material containing about 80 per cent of copper and 20 per cent of nickel has been adopted, and this is undoubtedly the best blading material existing. Steel blading, drawn in the same way as the usual brass section, has been used in the United States with fairly good results.. The process of drawing turbine blades gives an extremely tough skin to the metal used, not only increasing the tensile strength, but greatly decreasing the chances of erosion. It seems probable that the usual caulking piece now adopted will be discarded in favor of a machine-divided strip into which the blades may be fitted, and instead of the slotting, wiring, lacing and soldering process at the tip, a similar machine-divided shroud will be used. This will give a far stronger construction and will enable finer clearances and better workmanship to be obtained, at the same time considerably reducing the cost of manufacture and the risk of blade stripping. The chief causes of the latter may be set down to bad workmanship in fixing the blades, defective blade material, excessive cylinder distortion—this probably the most fruitful cause and a serious one, being due to bad design—whipping of turbine spindles (also due to bad design or bad balancing), wear of bearings, which is very remote, and the introduction of extraneous substances such as water or grit. In fact, blade stripping may be said to occur generally from preventible causes. Small vibrations of very high frequency occasionally set up an action in certain rows of responsive length that fatigue the blade material and cause the loss of blades without any fouling at all.—*London Times Engineering Supplement.*

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MOTOR CARS IN WALES.

The country of Glamorgan, in South Wales, is one network of steam railways, whose principal business is the handling of coals to the seaboard. These systems, together with the rigid regulations of railway crossings in Great Britain, make the introduction of electric interurban trains impracticable; but inasmuch as the country had a population of 860,022 in 1901, it has become necessary to improve upon the old methods of

handling the passenger traffic, and for that purpose the steam motor car has been introduced in several places as a substitute for the electric tram. About a year ago the Alexandria Docks and Railway Company placed one of these cars on their line between Caerphilly and Pontypridd, and the experiment proved so satisfactory that a second car was placed on the same line September 28. This car, which is described as being 64 feet 11 inches in length and weighing 35 tons, is the finest yet put upon the railways in this country. Steam is generated in a

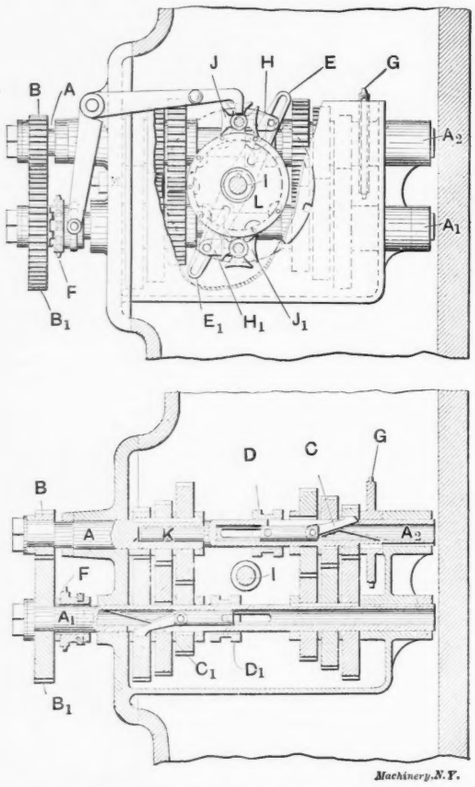


Fig. 65. Device Patented by E. J. McClellan, Jan. 9, 1900, No. 641,219.

locomotive type of boiler, which is fitted with Drummond water tubes. The cylinders are fixed on the outside of the bogie frame plates, and the water tanks, containing 350 gallons, and coal bunkers, having a capacity of 1 ton, are placed on each side of the boiler and are carried on the underframe of the carriage. The steam regulator and reversing gear are worked from either end of the car, so that the driver has at all times a clear lookout in the direction in which the car is traveling. In addition to steam brakes, powerful hand brakes are fitted to the wheels of each of the two bogies upon which the car is carried.

There is seating accommodation for 54 passengers. The seats, which are placed longitudinally, are plaited rush matting over springs. Passengers enter by a sliding door from a vestibule at the rear end, and, in addition, doors are placed on each side of the carriage to facilitate expedition when dealing with heavy traffic. Electricity, generated by a De Laval steam turbine dynamo placed on the footplate, is used for lighting the car. Numerous substations have been established for the accommodation of passengers, just as in the case of interurban electric trams, and the service seems very acceptable.

* * *

In order to appropriately celebrate the completion of the Simplon Tunnel, an international exposition will be held in Milan, Italy, from May to November, 1906. It is expected to be the largest European exposition ever held outside of Paris. The prominent feature of the exposition will be that processes of manufacture will be shown wherever possible. In short, the machinery will in general be in motion, thus making a large part of the show live exhibits. Intending United States exhibitors may obtain further information from J. H. Gore, George Washington University, Washington, D. C.

VARIABLE SPEED MECHANISMS.—7.

GEARED DEVICES. (Continued.)

Fig. 65 shows a typical combination of gearing for effecting speed or feed changes in machine tools without the necessity of stopping the machine or without the need of inspection on the part of the operator of the position of the locking members. This device was patented by E. J. McClellan, January 9, 1900, No. 641,219. There are four sets of spur gears of varying pitch diameters arranged so that their pitch diameters increase in order, thus forming the so-called cones of gears. These cones are mounted on two parallel shafts, A_1, and the compound shaft, A and A_2. Each shaft has one set of gears mounted solidly thereon, but the other set of gears is mounted loosely on the shaft and connection thereto is made by means of sliding feathers C C_1. These feathers are controlled by clutch collars D D_1, which in turn are connected to the operating levers E E_1, shown in the upper view. These levers are mounted on a common pivot, but are independent in action. The problem of shifting the keys by a simple hand motion so as to get all the possible combinations in geometrical series is a somewhat difficult one, and is ingeniously effected in this device. It makes use of the Geneva stop motion by which

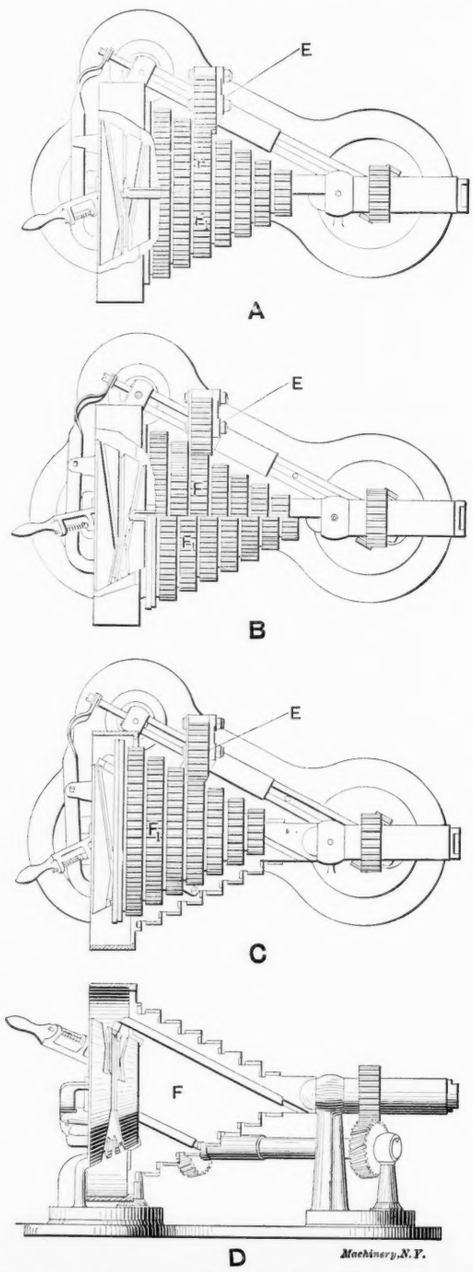


Fig. 66. W. P. Shattuck's Patent, Sept. 10, 1901, No. 682,391.

the sliding feathers are alternately slid back and forth to engage the respective gears necessary to transmit the required ratio. The levers E E_1 carry pins which engage the grooves in the collars D D_1 and on the opposite face they are slotted. In these slots work crank-pins in cranks H H_1, which are attached to the Geneva disks J J_1. It will be noticed that the half of one step is brought into osculation with the pitch diameter of its neighbor so that the pinion E will roll off from one step and start onto the next without shock, and as the cone turns around the half which has been displaced is returned to its normal position so that when the cone has revolved 180 degrees the new speed is taken up smoothly. The

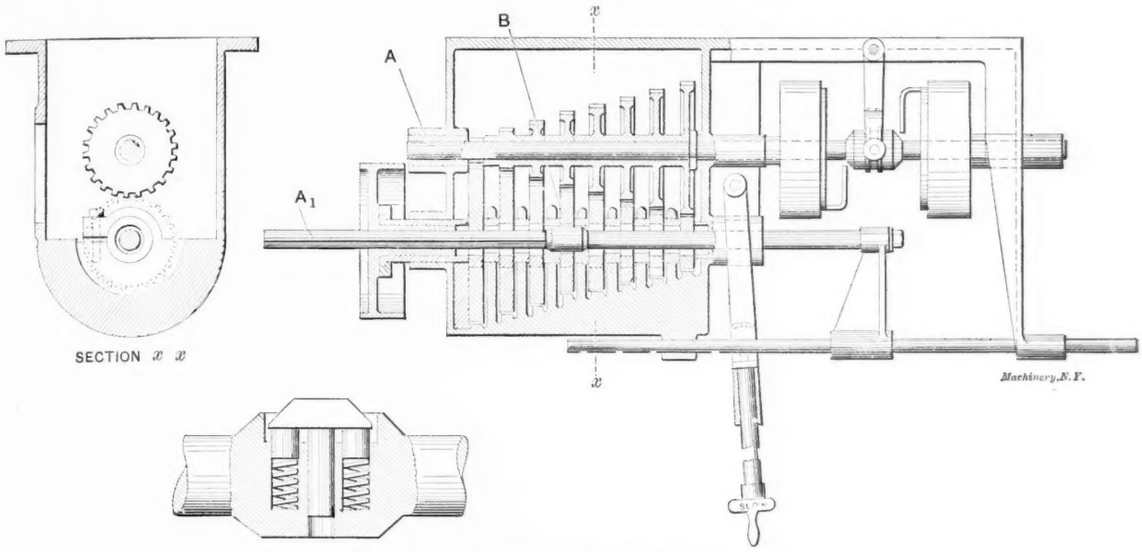


Fig. 67. Patent No. 633,003, granted to W. L. Schellenbach, September 17, 1901.

upper shaft is in two parts, the right-hand part A_2 being reduced at K and fitted to a hole bored in the other part A. Motion is communicated by sprocket F through B and B_1 which are change gears and thence through the gear cones to shaft A_2 and sprocket G. When speed changes are to be made the bellcrank lever must be lifted to unlock the disk and this motion throws out the clutch F.

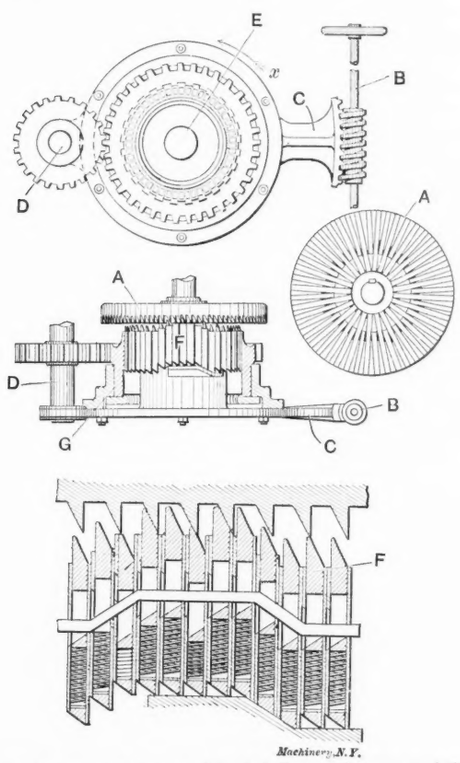


Fig. 68. An Arrangement proposed by I. J. Foccart for use on Automobiles, Patent granted Dec. 30, 1902, No. 716,881.

W. B. Shattuck employs a bold scheme for effecting speed change. This device, illustrated in patent No. 682,391, granted September 10, 1901, consists of a cone of gears which are split longitudinally and are tongued and grooved so one half of the cone F is shifted on the other on a line parallel with one side of the cone. In this manner the pitch circle of one

diagrams are practically self-explanatory, so far as the principle is concerned, so it is not necessary to enter into a detailed description of the somewhat complicated device by which these changes are effected at the critical periods without disaster.

Patent No. 683,003 was granted to W. L. Schellenbach, September 17, 1901, for a variable-speed mechanism of the countershaft type. In this invention two shafts A A_1 are arranged parallel, one being the driver and the other the driven. On shaft A is placed as many spur gears as there are speed changes required. The corresponding gears on shaft A_1 are made with large bores in the hubs, and normally all the gears are out of engagement with the driving gears, save the one which is actually transmitting motion to the driven shaft. This gear is raised into engagement by means of a collar B

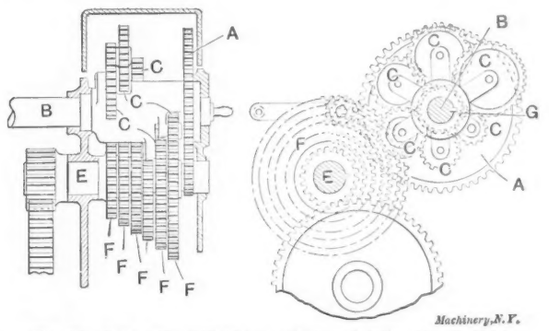


Fig. 69. Patent No. 727,404, granted to J. Mills, May 5, 1903.

secured to the sliding shaft A_1. This collar is provided with a spring key, as shown in an enlarged view in Fig. 67, which springs into place into a keyway provided, as the gear turns around. The idle gears do not hang upon the rotating shaft but are supported at the bottom by the enclosing case. A feature of this device is that in changing from low to high speed or *vice versa* all the intermediate gears must successively be put into motion so that the change is made progressively and without the shock that would otherwise result.

In Fig. 68 we have a speed change apparatus patented by I. J. Foccart, December 30, 1902, No. 716,881, for use on automobiles. This is one of the few attempts to produce a positive-geared speed variator in which speed changes can be made by imperceptible gradations from the highest to the lowest speed. A plan view of the apparatus is shown in the upper cut and a side view and face view of disk A under-

neath. The lower view shows a section of the teeth enlarged. Change of speed is effected by the screw and handwheel *B*, which shifts the plate *C*. This turns on the pivot *D*, thus changing the position of center *E* with the center of the driver *A*. Radial teeth are cut in the lower face *A* in which engage the peculiar tooth carriers *F*, which are supported in the gear *G*. At one point these tooth carriers are lifted above the normal plane to engage the radial teeth in the face of *A*. To compensate for the lack of uniformity of tooth spacing and width in *A*, the tooth carriers are made with spring plungers that collapse and adjust themselves to the required height to engage properly with the radial teeth faces. It is scarcely necessary to remark that there is an almost total lack of proper tooth action and that such a device must necessarily be quite impractical for any purpose where any but very moderate power is transmitted. That the idea might not be worked out into practical form is not impossible, however.

The speed-changing mechanism for machine tools shown in Fig. 69 was patented by J. Mills, May 5, 1903, No. 727,404. In this device a multiplicity of spur pinions *C* is mounted on a hub with the toothed wheel *A*. The hub is mounted on a shaft *B* carrying a long pinion which meshes with each of the gears *C*, etc. Shaft B is the driver and all the intermediate gears run constantly, in the scheme shown although this is not a necessary feature of the device. Parallel to the shaft *B* is another shaft *E* on which are mounted the gears *F* of varying dimensions. The rotation of the toothed wheel *A* by means of a pinion and hand lever brings anyone of the desired intermediate pinions *C* in mesh with one of the gears *F*, and

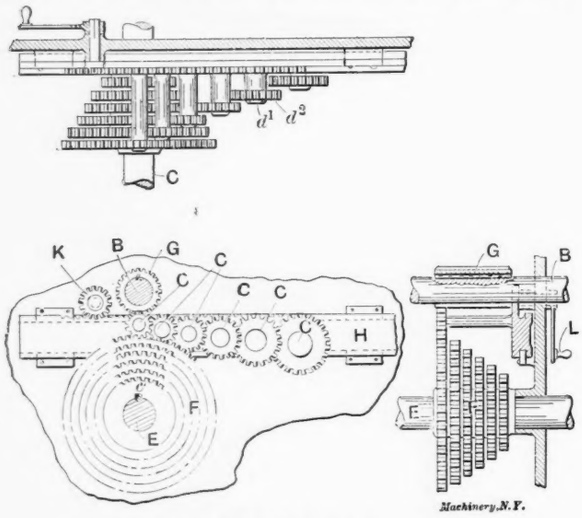


Fig. 70. A Modification of the Idea shown in Fig. 69.

thus effects the desired speed change. This device has been successfully applied to shapers, and speed changes are readily made without stopping the machine. Although in the drawing shown all the gears *C* are in mesh with the pinion *G*, an alternative plan and one employed in practice is to make the hub *A* eccentric to shaft *B* so that only the desired intermediate gear is running, the others remaining stationary since they are thrown out of mesh. In the same patent specifications the inventor shows the intermediate gears arranged on a rack bar in which case rectilinear motion is necessary to effect the desired speed changes. In this device, Fig. 70, the intermediate gears *C* are carried on a rack bar *H*, which is shifted by the pinion *K* and hand lever *L*. The driving gear is *G* and the intermediates convey its moton to any one of the cone of gears *F*, selected.

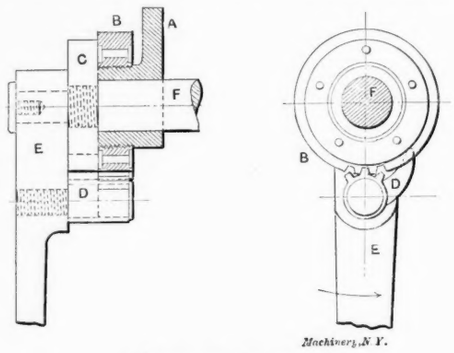
* * *

Krupp's works at Essen find employment for some 55,816 hands. Overtime is at present being worked in the gun factories two or three days a week. In the hammer and roller works double gangs have been introduced throughout, and the number of men has been increased. The orders for war material are so enormous, and promise to attain such proportions, that the construction of a new large gun shop is being contemplated.—*Mechanical Engineer.*

This does not appear much like the immediate era of universal peace.—EDITOR.

NON-RETURN STARTING CRANK FOR GAS ENGINES.

A novel and ingenious safety starting crank brought out in France, is described by *La Vie Automobile*, and translated by the *English Mechanic*. Referring to the two views of the device herewith, *A* is a bracket fixed to the front cross member of the frame, in which the end of the crankshaft *F* has a bearing. Upon the hub of this bracket is located a roller clutch or free-wheel arrangement *B*, the inner part of which is fixed to the bracket so that the outer part can only turn in one direction (left-handedly in the plan view herewith, which shows the device from the back or motor side). The periphery of the free-wheel *B* is cut with a number of gear teeth



A Non-return Starting Crank.

with which mesh corresponding teeth on the hub of the pawl *D* pivoted on the crank *E*, which is mounted loosely on the end of the crankshaft *F*. The pawl *D* is adapted to engage into sawtooth notches on the disk *C* fastened upon the end of the crankshaft. The action is as follows: Suppose the engine is to be started and the starting crank is turned left-handedly (in the drawing) to accomplish this. Owing to the slight friction of the free-wheel *B*, it will not commence turning at once, but will remain stationary, and owing to its teeth meshing with those of the pawl *D*, the latter will be swung about its pivot and engage into one of the four notches on disk *C*. There is then a positive driving connection between the starting crank and the engine-shaft, and the engine can be started in the usual way.

Now suppose that while the operator is pulling on the starting crank a back explosion occurs, which moves the crankshaft back against his pull. The free-wheel *B* cannot move backward (right-handedly in the drawing), and its teeth cause the pawl *D* to move on its pivot like a planetary pinion, thereby becoming disengaged from the notches in the disk *C*, and freeing the starting crank. The device is made by Breviaire and Kenel, 49, Boulevard Gouvion-Saint Cyr, Paris.

* * *

We commonly regard a second as a very brief interval of time, but in instantaneous photography it is often a measure of enormous extent, especially for some of the work done in the laboratory. For example, Prof. Brown showed in the course of his lecture on the photography of invisible phenomena, given before the A. S. M. E., December 6, a photograph of a falling drop of water made with an exposure of 1-10,000 second. In such work a shutter is not used but the object is illuminated by a flash, being in this case the explosion of a thin glass bell filled with oxygen and hydrogen gases in the proportion H_2O. So rapid is the combustion that the whole mass in a small bell is fired before the thin glass walls (thinner than writing paper) can yield perceptibly. Exposures of far less duration are made with electric sparks by charging a Leyden jar with a spark and using the secondary spark for illumination, it being possible in this manner to get exposures of an estimated period of 1-1,000,000 second!

* * *

On account of the great number of calculations necessary in compilation of some of our data sheets, it is impossible for the editors to check all the values given. For this reason we should esteem it a favor that we be informed of any errors that are found so that they may be corrected in future reprints.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

For obtaining the side of a square which shall be equal in area to a given circle, the empirical method, devised by Ahmes and described in the Rhind papyrus, 4,000 years ago, is very simple and sufficiently accurate for many practical purposes. The rule is: Cut off one-ninth of the diameter and construct a square upon the remainder. This makes the ratio of the square of the radius to the area 3.16, and the error does not exceed two-thirds of one per cent.—*The Practical Carpenter.*

An Italian engineer, Signor Jelpo, has invented a submarine elevator for raising wrecked vessels. The invention was recently put to a practical test, with complete success, in the bay of Naples, where a stone-laden barge, sunk a couple of years ago, and lying at a depth of about 50 feet, was brought to the surface with ease. The weight lifted was about 60 tons. The apparatus consists of compressed air chambers of canvas and wire, each having a lifting capacity of 60 tons, and it is possible to attach as many of these as may be necessary, after calculating the weight to be lifted.

One of the interesting exhibits at the American Railway Appliance exposition held in Washington in connection with the recent International Railway Congress, was a new process for quickly obtaining a temperature of 1,000 to 1,100 degrees F. The substance is called "calorium" and is ignited with a match giving a double chemical reaction. The purpose for which it was exhibited was the soldering of railroad bonds. By the use of calorium the ends of the rails were quickly raised to a dull red, melting the solder on the bond terminals and uniting them permanently to the steel, thus making a perfect electrical bond.

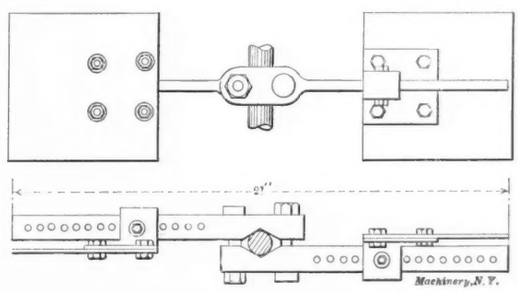
An opportunity was afforded a few weeks ago to test the destructive action of a large quantity of dynamite on the banks of a ship canal. The steamer *Chatham* took fire in passing through the Suez Canal and had to be scuttled. The cargo included 85 tons of dynamite and a quantity of nitroglycerine. It was not practicable to salvage the cargo and raise the steamer so she was blown up September 27. Considerable damage was expected but contrary to the expectations, it was comparatively small. This fact is interesting inasmuch as it has been frequently declared that our Panama Canal might in time of war be rendered useless by the explosion of a comparatively small quantity of dynamite in a lock or other strategical position. It would appear from the result of the explosion of the *Chatham* that the possibility of great damage being caused in this manner is remote, with the quantity of high explosive that could be smuggled into such a place in war time.

A patternmaker with some experience, in the neighborhood of government headquarters, writes as follows: "There are no private firms making patterns in Washington, D. C. All of us (patternmakers) are employed by the government. There is nothing for us outside of that. They have finished the new pattern shop and it is up-to-date in every respect—all individual electric motors to the machines, dust pipes, etc. The patterns are commonly made of mahogany. They are examined by naval officers and are made to the one-hundredth part of an inch. This is unnecessary, but is done with every pattern. The patterns are varnished a light color with the core-prints black. They must be beautifully finished, in general appearance as well as to accurate dimensions. No leather fillets are used. The webs must be rabbetted in wide enough to work the fillets from the solid and have the joints perfect. Neither brad holes nor brads can show in the patterns. If the strain will be too great for glue to hold the parts in place, screws must be used. These screws are countersunk for wood plugs. The wood plugs are inserted in the countersunk holes over the screws, the grain of the wood in the plugs running the same as in the surrounding surface of the pattern. This practice is quite different to some of the hurry up, putty up, jobs I have seen elsewhere. All work is done on the eight-hour day plan."—*Wood Craft.*

The transmutation of the baser metals into gold or silver was the alchemist's dream, and whether the possibility exists or not, the fact remains that these ancient cranks did much to develop the modern science of chemistry. With the widening of vision due to recent discoveries which seem to indicate the possibility that the so-called elemental substances can be divided or resolved into new forms, the ambition of these ancient workers does not seem quite so absurd. We are already able to make diamonds, minute, it is true, but the fact that carbon can be changed into the crystalline form characterizing the diamond shows that there is the possibility of making these precious gems of commercial value. A recent report by Consul-General Guenther of Frankfort, Germany, reviews what has already been done by the French chemist Moissan and mentions the recent interesting experiments of Dr. Burton of Cambridge. Dr. Burton's experiments seem to indicate that perhaps high temperature is not so necessary as a high pressure under which the peculiar crystallization takes place from a yet unknown solvent. Dr. Burton in his experiments used a molten alloy of lead and metallic calcium which held a small quantity of carbon in solution. The separating of the calcium by means of steam introduced at a low red heat caused the formation of small crystals, having properties identical with those of natural diamonds, whereas at a high red heat graphite was formed. The fact that extremely high temperature is not necessary appears to simplify the problem somewhat.

A FAN AS AN ABSORPTION DYNAMOMETER.

The use of a fan as a power-absorption apparatus is no great novelty for loading steam engines, but the extension of the idea so as to measure the power absorbed is interesting, if not distinctly novel. The *Practical Engineer* in a recent issue describes a dynamometer of the fan type which is the design of Mr. W. G. Walker, Emery Hill, Westminster, England. The apparatus consists of a pair of vanes which are clamped upon the engine shaft, with means provided for adjusting the vanes radially on the arms. The size described is suitable for powers ranging from ¼ to 26 horse power and for speeds from 250 to 2,000 revolutions per minute. The length of the arms over all is 21 inches, and three sizes of vanes are provided. The



device is calibrated for all speeds up to 2,000 per minute, and the power absorbed at different speeds and with different sets of vanes is recorded. It is used by clamping the arms upon the shaft, adjusting the vanes and then running the steam, gas, electric and other motor up to its working speed and load. Then, knowing the speed, and the position and size of the vanes, the horse power is known from the tabulated laboratory tests which are given out with each dynamometer. The advantages of the device for small powers are that the apparatus is much simpler than a Prony brake, the heat is absorbed and dissipated by the atmosphere, and the torque automatically increases with the speed; a disadvantage is that

the load cannot be adjusted for a given speed without stopping the motor. The only apparatus necessary besides the vanes are a revolution counter and a time piece.

THE TEMPERATURE OF FLAME.

In a paper on the temperature of flame read by Mr. Arthur Smithells before the Institute of Gas Engineers he spoke of the uncertainty of what is meant by the temperature of a flame. Where gas is burning in the usual matter by allowing it to flow into the atmosphere without previous mixture with air the flame consists usually of thin shells of combustion which vary in temperature. In the middle of the flame there may be a temperature not very greatly above that of the surrounding air and at the edges of the flame, not more than one-fourth inch away, the temperature may be above the melting point of platinum. It is therefore obviously absurd to attempt to measure by ordinary means, as for example a glass thermometer, for such an experiment would be subjected to a variety of conditions and could not possibly be an accurate index of what the maximum flame temperature is. The author then alluded to the method employed by Prof. Fery which is based upon the reversal of the D line of sodium vapor when viewed against an electric filament of known and alterable temperature. By this method Fery estimates the temperature of the electric arc to be 3,760 degrees C. (or 6,800 degrees F.) and that of the sun to be 7,800 degrees C. (14,000 degrees F.). The following is a table of maximum flame temperatures as determined by Fery, and published in 1904:

	Deg. C.	Deg. F.
Bunsen burner, gas fully aerated	1,871	3,400
Bunsen burner, insufficient air	1,112	3,114
Acetylene flame	2,548	4,618
Alcohol flame	1,705	3,101
Denayrouze Bunsen, alcohol and air	1,862	3,384
Denayrouze Bunsen, ½ each alcohol and petroleum spirit	2,053	3,727
Hydrogen, free flame in air	1,900	3,452
Oxy-coal gas blowpipe flame	2,200	3,992
Oxy-hydrogen blowpipe flame	2,420	4,388

LOSS OF VELOCITY RATIO DUE TO BELT ELASTICITY.

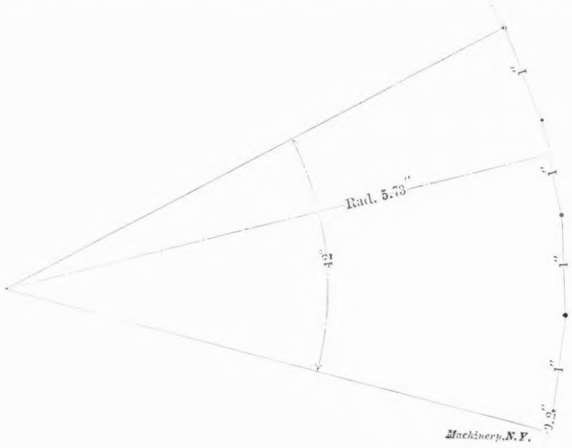
An interesting condition met with in belt driving is referred to by the *Practical Engineer*, and that is the difference in velocity ratio other than that due to the difference in diameters, which may exist between two pulleys when the driving belt is elastic. It is usual to assume that the number of revolutions for two shafts connected by a belt is inversely as the diameters of both driver and driven pulleys, and for most purposes it is quite safe to accept it as such, although strictly speaking, not quite true. When a belt is doing work, the tight or working side will be constantly stretching, considerably more than the slack side, the amount of stretch depending upon the elasticity of the belt and the working tension brought upon it. Consequently the pulley and shaft which are being driven will fall behind in speed by an amount equal to the creep of the belt. It has been shown that by using a very elastic belt the driven shaft was made to run at about half the speed of the driving shaft, although both pulleys were practically of the same diameter.

This proposition is interesting in a number of ways; it suggests the possibility of varying the speed of the driven pulley by manipulating the tension of the belt. For example, suppose the belt was in the nature of a coiled spring, the extension of the spring would depend upon the tension and this in turn, as pointed out, would affect the ratio of driver and driven pulley speed. Now, it would be possible to limit the extension of the coil spring by means of a chain arrangement inside the coil, and this would have the effect of definitely fixing the amount of extension. Such an arrangement, however, would be of little practical value, but applying it in another manner, as for the purpose of illustration, making a flat belt with a series of cross cuts, so arranged that as it was stretched the cuts would assume a diamond shape, we would have a condition by which the extension of the belt might be controlled and that is, by providing guides at the sides of the belt where it leaves the pulleys, which would engage flanges attached thereto and thus prevent the extension going beyond a pre-determined limit. The amount of extension could thus be changed while in operation and the velocity ratio brought under control of the operator. The slack side of the belt would have to be taken care of by an idler pulley.

The fact that belt creep can be so great as to allow a driven pulley to fall 50 per cent behind its theoretical velocity is important, as it has a direct bearing upon the working of high-speed internal grinders, especially those having rubber bands for driving. It is doubtful if some of the high-speed grinding wheels run at the calculated velocity which, being so, would often account for poor working.

TO LAY OFF AN ANGLE WITH SCALE AND DIVIDERS.

A useful method of laying off angles with dividers and scale is described by an English engineering publication, and although it is approximate in its results it should be accurate enough for many purposes. Set the dividers to a radius of 5.73 inches and describe an arc of indefinite length. On this arc lay off the desired angular measurement, making each degree equal 0.1 inch on the arc. Of course each degree is not stepped off but the arc should be stepped off in small multiples in order to more closely approximate the linear measurement to the arc. For example, suppose an angle of 42 degrees



is wanted; it may be laid off as shown in the accompanying cut. After striking the arc with a radius of 5.73 inches set the dividers to 1 inch (10 degrees) and step off four places. Then set them to 0.2 inch (2 degrees) and step off one space to complete the measurement. It will be noticed that 5.73 inches is nearly 5¾ inches and this radius will give, perhaps, on the average better results in the matter of accuracy than the theoretical radius. The rule is based on the fact that 180 degrees ÷ π = 57.3 degrees, *i. e.*, a radian or an arc length equal to the radius. Hence, making the radius on a scale of one-tenth 57.3 makes each degree 0.1 inch in length.

SOME EXPERT OPINIONS ON TECHNICAL EDUCATION.

Some opinions on technical education, of interest, if not of value, were expressed at a meeting of a special commission on industrial and technical education held in Boston recently. One speaker referred to the well-known fact that there is a gap in technical education which is not filled by the public or technical schools. This gap is represented by the men so educated that they can fill the place between the industrial high-private and the industrial first-lieutenant. He said that we have done a great deal to develop captains of industry, but the places of non-commissioned officers, as it were, are lacking in competent men. He complimented the correspondence schools and said that they are doing a great work in this direction, there being something like 30,000 men taking instruction in this manner. From these remarks it may be inferred that men trained by a correspondence course, while not having the advantage of a technical training, surrounded by laboratory conveniences, will have an appreciation of the theory of their trades which better fits them for directing their work in the minor capacities.

Regarding trade schools, it was asserted that there is no

danger of flooding the ranks of industry, though some workingmen are afraid of it. Formerly, it is true, that employers did use schools for that purpose, but the situation is now entirely different. It is not true that a trade school will make it hard to maintain a standard of wages, but rather they help to maintain a high standard of efficiency and a corresponding standard of wages. It is also generally recognized that trade unions are doing good service in maintaining a standard of wages. The matter of trade education must be looked at broadly for the first purpose of the school is to benefit all the state, not any section or any class of citizens. Those who must earn a living should be shown how to do it. The Puritan idea is to think of abstract virtues and not of dollars and cents, but in real life both must be included. It is the poor, untrained men who are most likely to get into crime and distress. Make them happy and contented and crime decreases, and the way to do it is to make them productive, for true happiness lies in productive work.

AN ELECTRIC ACCELEROMETER.

Paper read by Mr. R. B. Owens before the November 2, 1904, meeting of the Canadian Society of Civil Engineers.

The advent of the electric motor as a competitor of the steam engine, especially in the traction field, has given rise to certain acceleration problems unfamiliar to engineers of a generation ago. At a time when the train mile was a satisfactory unit in which to reckon haulage costs, there was little occasion to bother with acceleration. Now, however, when neither the train mile, car mile, nor ton mile suffice, even when coupled with a speed factor as a basis of estimation and analysis, and when to maintain certain schedules more energy is expended in accelerating than in overcoming frictional and grade resistances, a simple, accurate, and reliable means of measuring acceleration is urgently demanded,—a means at least comparable in simplicity and accuracy to those employed in the measuring of the quantities of which it is the second

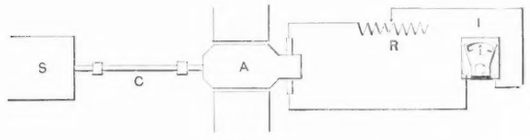


Fig. 1

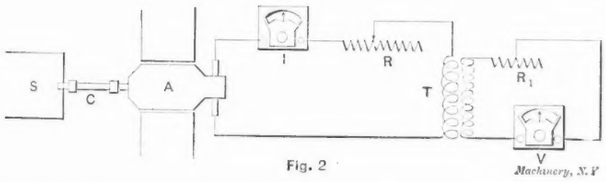


Fig. 2

Machinery, N. Y.

and first differential with respect to time. Of practical methods of measuring velocity or speed, at least of machines, one of the most satisfactory, if not the most satisfactory, involves the use of a suitable constantly excited or permanent magnet dynamo mechanically driven by the part whose velocity is to be measured, and electrically connected through an ammeter to a circuit of constant coefficients as shown in Fig. 1.

S is the shaft whose velocity is to be measured. *C* is a mechanical coupler. *A* is the armature of a small permanent magnet or constantly excited continuous current dynamo wound so as to have a negligible reaction within the limits of its use. *R* is a variable non-inductive resistance and *I* is a zero center d. c. ammeter. The reading of *I* will be proportional to the speed of *S* and, by adjusting *R*, can be calibrated in the revolutions per minute, feet per second, or miles per hour as desired. As the current through *I* is proportional to the speed, it is only necessary to determine the rate at which the current varies in order to have a measure of acceleration. This is simply and easily done by inserting in the circuit with *I* a transformer *T* with its secondary connected, for purposes of adjustment, through a non-inductive resistance R_1, to a zero center d. c. voltmeter *V* (see Fig. 2). The reading of the voltmeter *V* will then be proportional to the acceleration, positive or negative, of the shaft *S*.

Substituting recording instruments for the indicating ones shown, we have a recording speed indicator and a recording accelerometer. The transformer must have a straight line saturation curve and a large transformation ratio as the secondary induced voltage is necessarily small, and the voltmeter *V* must also be sensitive. The calibration of the ammeter as a speed indicator is effected by driving the armature *A* at different constant speeds as shown by ammeter reading, and taking the revolutions in a given time by means of a revolution counter and stop watch. The calibration of the voltmeter as an accelerometer is best done by driving the armature *A* by a separately and constantly excited motor having applied to its armature, preferably of small momentum, a voltage varying approximately as a linear function of time. With proper manipulation of apparatus the ammeter readings plotted against time will be a straight line whose slope will be constant and equal to acceleration and to the constant reading of the voltmeter to within a constant.

In some tests made in the writer's laboratory not long ago, *A* (see again Fig. 2) was the armature of a small low voltage separately excited d. c. generator; *S* the shaft of a 3 horsepower, separately excited d. c. motor to whose armature by a potentiometer arrangement a steady increasing or decreasing voltage could be applied; *I* and *V* Weston ammeter and milivoltmeter, and *T* a small lighting transformer with a transformation ratio of 20; and excellent results were obtained, speed and acceleration being read to exactly the same degree of accuracy that Weston d. c. ammeters and voltmeters are capable of. With recording instruments substituted, this would seem to meet every requirement of a practical apparatus for the measurement and recording of velocity and acceleration in railway work both steam and electric, and is applicable, of course, in many other connections.

MAKING TIGHT SCREWED JOINTS.

In an article in the December issue of the *Valve World* on the subject of making tight-screwed joints for very high pressure, Mr. R. S. Crane says that he is sure the trade generally does not understand the conditions that are necessary in order to make good work in this line. If the ordinary steam fitter were called upon to put up piping that should stand 200 or 300 pounds of steam pressure, he, no doubt, would feel that he was taking a very large responsibility. If he were called upon to do a job that should stand 1,000 pounds of air pressure he would not feel like taking this responsibility at all, and any one taking this responsibility would feel that he was obliged to resort to very extraordinary means in order to accomplish such a result; if called upon to do such work with the ordinary material that is manufactured and supplied in the general market, he would say that it was an impossibility to do it.

The Crane Company, however, had occasion some time ago to make joints tight in an 8-inch line so that they would stand 1,000 pounds of air pressure, and this was accomplished with the regular weight of line pipe and a coupling weighing about 24 pounds (which is the weight of a first-class line pipe coupling). The result of the experiment on thirty-two joints was that on the first test all were tight excepting one, and when this one joint was taken apart and again made up it also proved tight.

The secret of making such a joint is to overcome the friction in screwing the pipes together. Friction is due to the large amount of surface, especially when the joints are coming up close to a bearing. Any grit or gummy material in the joint also tends very largely to produce friction. Friction produces expansion, and as the pipe is lighter than the coupling it expands more than the coupling, and then when both again become cool the pipe shrinks more than the coupling, thus causing a tendency to leak. It is, of course, evident to any one who has given any thought whatever to this subject, that in order to make tight such joints as are mentioned above, the iron must be brought together as solidly as possible. To get such results it is imperatively necessary that the iron should be absolutely clean, and then it is essential that the very best lubricant is used in order to reduce the friction.

In order to produce good joints, it is not necessary that

the threads should be absolutely perfect, nor is a taper essential (one of the couplings in the experiment herein referred to had no taper at all, and others very little taper), nor is a large amount of bearing necessary; in fact, one joint was made with a thread reduced to ⅜ inch in width, and this joint was tight at 1,500 pounds hydraulic pressure, which proves that the bearing was not essential to the making of a tight joint, and that the length of thread was not essential to prevent stripping of the thread from the coupling or the pipe. This also proves another point that is not understood, and that is that it is not essential, in order do good work, to have especially long threads. In fact, it is believed that especially long threads are a detriment in making a good joint, for it stands to reason that such long threads tend to produce friction, which prevents the iron from coming up closely together, and the irregularity of the thread on the pipe tends to prevent the iron coming up in the closest contact. This will be better understood if we go to a great extreme in the matter. For instance, should it be undertaken to make a joint on 8-inch pipe, with a thread 6 inches long, the irregularities and friction would be so great that it would be impossible to get absolute thread contact.

THE REALIZATION OF IDEALS IN INDUSTRIAL ENGINEERING.

Extracts from a Paper read before the December Meeting of the A. S. M. E. by H. F. J. Porter.

Andrew Carnegie, when asked by a number of financiers whether he thought that the difference between one style of organization and another amounted to much, providing the company had an up-to-date plant properly located, said in effect that should some great catastrophe destroy all of his mills, but spare his organization, which had required many years to perfect, he might be inconvenienced temporarily, but that he could depend upon his organization to re-establish his business. If, however, he should lose his organization, even if his mills which were the best in existence were left intact, he would not have time nor strength to rehabilitate himself in the business world. Just as we have, for instance, recently seen it demonstrated that opposing armies and navies may have exactly the same guns, but that the side which has behind those guns the men of superior physique, character, intelligence and skill will win the battle, so also it has been proven that it is not the tool that determines either the quantity or quality of product, but the qualifications for efficiency possessed by the man behind the tool who controls and directs it.

What then are the qualifications with which a high grade organization should be endowed in order to attain a high standard of efficiency? Inasmuch as, after all, an organization is but a collection of human beings, it stands to reason that if as an entity it is to be of high grade the units of which it is composed must also be of high grade.

The attributes which human beings possess in common fall into three classes, *viz.*, physical, moral and mental, and in any manufacturing enterprise it is evident that the physical attributes are the most important. No matter how moral or intellectual a man may be, if he is a weakling, if he has not health, he cannot be an efficient part of an active organization.

Next he must be of high character, for no matter how healthy or intelligent a man may be, if he is immoral, *i. e.*, if he is dissipated, his condition physically and mentally while at work cannot be such as to qualify him as an efficient member of a high grade organization. His physical and mental powers are gradually affected, his sense of responsibility weakens, he becomes irregular in attendance, careless in attention to his duties and cannot be depended upon.

And finally, it is evident that, given a man of good physique and strong character, the higher his intelligence and skill in the direction of his duties the better qualified he will be to accomplish his daily tasks, but it is also evident from the preceding considerations that important as are these latter qualifications they must be subordinate to the other two and considered last in relative importance.

Now, I claim that the ordinary system of management in selecting and maintaining an organization, reverses the order in which the value of these qualifications for membership is estimated.

The questions usually asked an applicant for employment are:

First. Have you had a college education?

Second. What has been your practical experience?

Third. Have you ever been discharged? If so, what for?

Fourth. Give a list of people for whom you have worked.

Occasionally: Are you a drinking man?

But the self-estimate of what constitutes a drinking man makes the answer of little worth, and scarcely any interest is aroused by the amount of evasion displayed by the applicant.

Now, although we have seen that the human asset is of greater importance in an industrial enterprise than its mechanical possessions, I think I can safely say that infinitely more pains are taken in obtaining a machine or tool, to see that it is covered by detailed specifications and inspected during construction and before acceptance, than is given to securing the man who will be put in charge of it and held accountable for results from it afterwards. Experts from at least one department and frequently from several are consulted, and much time and thought are devoted to the consideration of the machine, but we rarely hear of a recognized labor or employment department in a shop, and when there is one it is seldom intelligently administered. Usually little care is taken in the selection of the men, and no thought is given to their improvement during their time of service. They are taken on and laid off without a thought of consideration for their welfare or convenience. No men can work at their best efficiency under these conditions.

Now there is one marked difference between machines and the men who operate them which should be noted here. Machines, no matter how well they may be cared for, depreciate from five to ten per cent per year owing to the advent of other and improved machines, while men, if they are properly cared for may appreciate in value several hundred per cent in the same time. Yet I maintain that as a general rule machines and tools are nurtured, fostered and preserved long after their period of usefulness has expired, while the permanency of service of the men of the organization who operate them receives comparatively no consideration whatever. It cannot be expected that the men of an organization will show any spontaneous enthusiasm for interest in or loyalty to a management that openly displays so little interest in their welfare.

A system of shop management which is suited to one industrial enterprise may work only indifferently in another and be a complete failure in a third. This statement may seem to be trite and unnecessary, but I know from my own experience that as long as men are constituted as they are, and they have probably not changed much since the time of Hamilton, whenever unusual conditions develop in a shop under any form of management, suggestions as to remedies which have been successful elsewhere are at once made by people who are well meaning, but have no knowledge of the actual situation.

What is needed, however, is a careful study by those whose knowledge of the conditions as they exist constitutes them as most competent to analyze the situation and deduce proper methods of procedure. In any manufacturing enterprise a standing committee on which both employees and management are represented and which meets at stated intervals is an excellent method of "getting together" those who are competent to act that each may see the other side of the shield and obtain the other's point of view.

There are frequent occasions arising when the management is anxious to know what attitude the employees would take in case a change in policy is made On the other hand, the employees from time to time wish to lay a request before the management. In either case some temporary device is usually resorted to to meet the occasion. When a standing committee exists, however, a channel of communication is always open and each side keeps thoroughly in touch with the other on all matters of common interest. An honor system is thereby established among the employees and the discipline improves greatly. I have never failed to see a marked change come over the entire organization as it rose to its responsibility as

soon as the members felt that they were accorded recognition as rational beings and were consulted on matters of common interest. Generally the rank and file of the working organization is considered in the same category as the privates in an army, they are not supposed to think, but to do as some one above them has planned. The usual result, as might be expected, is that they do not use their brains for the benefit of the concern.

All questions regarding systems of wage payments should come before the standing committee. The introduction of any of the various merit systems can be brought about in a shop with little difficulty if the subject is intelligently discussed by the committee in advance. In this country an appeal to reason is always accorded sympathetic reception, whereas the forcible application of a policy based on general assumption meets with merited resistance. And I should say here that as all men work primarily for their support the wage question is the one which must be settled first and satisfactorily before any schemes of industrial betterment can be effectively developed. Men work for wages, and will go where they can get the most pay. But of two concerns, each paying the same wage, the one which extends the better treatment to its employees will be favored by the applicants for employment and by judicious methods it can obtain the better class of help.

Some work of common interest must be developed to engage the attention of the standing committee and the sub-committees which later may be appointed to handle details. The Suggestion System now so generally adopted by the foremost concerns is a good subject for the committee to handle. This system develops in the operatives the power to observe, improves their capacity of initiative and inspires their ambition. It has besides the great advantage of being in itself a paying institution both to the employee and the company, when the latter pays well for valuable suggestions.

This system may include suggestions from the employees regarding improvements in their own conditions of comfort and work. No one knows better than the workman himself if he is not working under the most comfortable circumstances, but he will naturally hesitate to complain. Yet every one knows that a man when comfortable can do better work than when he is uncomfortable, and should be given an opportunity to express himself regarding his condition.

The system should also include suggestions regarding improvements in processes and methods of work. The operative, if encouraged to think, will soon effect great savings in the work at which he is more of an expert than any one else who is not constantly engaged at it. I have recently seen a product considerably redesigned, the process of manufacture simplified and made much cheaper and the company put upon its feet largely through the introduction of the Suggestion System.

Meetings of the foremen should be held regularly, and instruction should be given to them in the proper handling and management of men to secure the best efficiency within the limits of fair and just treatment. It must be understood that in order to secure the best quality of work the mind of the worker must be as free as possible from worry about his position. Peace of mind cannot be maintained while conditions exist which entail arbitrary discharge from service or unexpected reduction of wages, nagging by foremen who are affected by favoritism, ineffective facilities for service, unpleasant and unhealthful surroundings, danger of accidents from unguarded machinery, or loss of life in inflammable buildings inadequately supplied with means of escape. On the contrary, credit should be given to each employee for every effort to do his part in advancing the interests of the company. A little encouragement at the right time will do much to arouse ambition and enthusiasm, without which nothing of moment is accomplished.

I have already shown that health, character and intelligence in the order named are the essentials to be sought for in selecting an employee, and when found should be fostered and improved. First, then, efforts should be made to raise and maintain at a high grade the standard of health of the organization. Good health means capacity for work, both in efficiency when at work and through increased regularity of attendance. Irregularity in attendance is one of the banes of good management and it can only be improved by a careful investigation into its causes and application of the proper remedy. Mutual benefit associations are now quite general, but those where either a doctor or trained nurse is engaged to instruct the employees how to prevent sickness as well as to administer prompt and effective treatment during incapacity for work are effective means of increasing efficiency. Instruction how to live properly, how to cook simple food, how to eat, bathe and sleep, and warnings against the use of patented nostrums will tend to preserve the health of the organization and raise the regularity of attendance. The latter can also be effected by the payment of a bonus annually to those whose presence has met a certain percentage of regularity.

Some managers say that they are not interested in knowing what their employees do outside of working hours. Some employees say it is none of the manager's business what they do in their own time. When, however, what the employees do in their time affects what they do in their employer's time, then it may be to the latter's interest to look into such matters. What the employer should desire is to have as few changes take place in his organization as possible. Now, it should be remembered that in every factory there are apt to be many operatives who, because they are strangers in the locality or from reasons consequent to their condition and circumstances, have no opportunities for social recreation and pleasures and no places to go to after working hours. Therefore, being more or less creatures of circumstance, they drift into associations and habits which may be debasing in their tendencies. This sort of thing leads to a lowering of the status of the organization through association, if they remain in it, or to an unsettled state if there are many changes due to constant removals. The social instinct in man causes him to seek companionship and if opportunity is given the members of the organization to attend lectures and other social gatherings which are attractive and at the same time elevating in their tendency the whole fabric of the organization becomes homogeneous of high grade and remains intact. And, finally, the education of the employee should receive the attention it deserves. Early opportunity should be seized to improve the mind of the employee as he grows. The wider his knowledge, the better he will perform his duties.

Apprenticeship schools in operation during working hours under the charge of a trained teacher are effective means of developing the mentality of the organization and at the same time of getting in close touch with the employee early in his career, and the longer he stays with the concern and the more money is spent on his improvement the more valuable he becomes as an asset and the greater the effort should be made to retain him in the organization. Schools should be established in the factory during evenings for the purpose of helping the employee to advance in the organization. Energy, coupled with character and knowledge, guided by tact and discretion, will open the avenues of achievement. Care should be taken, however, not to coddle the organization. Coddling engenders weaklings. Extending opportunities so that the employees can help themselves develops self-reliance, self-respect, and, at the same time, regard for the management. Such a policy promotes a strong and healthy organization. Employees are quick to feel any interest taken in their welfare and as quick to reciprocate. To increase the efficiency of an organization so that each employee is not only a passenger in the enterprise, but effectively pulls his own weight, should be the object in view.

* * *

It is the policy of the David Maydole Hammer Co. to replace any of their hammers which prove defective with proper usage. Some of their experiences with returned goods are amusing, as for example, the following: "Not long ago an old gentleman brought a nail hammer to the office. Said he was a carpenter, had just broken a piece from the face of his hammer, and asked if it was not defective. We knew by the shape that it was very old, which was verified by his admission that he had used the hammer continually for thirty years. We gave him a new one. Not because the old hammer had not done its work well, but for the old gentleman's 'cheek,' which was certainly 'well hardened.'"

N. Y. MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The annual meeting of the American Society of Mechanical Engineers, held in New York from December 5 to 8, was attended by over 700 members, and over 1,360 members and guests registered, making it not only the largest meeting of this society, but one of the largest that was ever held by any technical association. No attempt was made to use the society house on 31st Street, even for headquarters. Through the courtesy of the New York Edison Company, the handsome assembly and club rooms that they have fitted up for their employees in their new building at 44 West 27th Street were placed at the disposal of the society. The opening session was on the evening of the 5th, when retiring President John R. Freeman, of Providence, R. I., delivered the annual address. Mr. Freeman is one of the leading authorities of the country on fire protection and spoke mainly upon the fire protection of theaters. He gave an interesting résumé of the experiments and investigations which followed the Iroquois disaster in Chicago and the conclusions to which those investigations led, pointing out the utter inadequacy of the usual facilities for preventing the spread of fire in the modern playhouse. He criticised severely the asbestos curtain as now required in theaters because of its certainty to crumble at high temperatures, as has been proven by laboratory tests. The interesting statement was also made that various liquids and powders used in hand grenades and similar apparatus which had been purchased in different cities were found to be valueless, or at least not particularly better than water, or sand—the grenades contained a brine of salt and water and the powder was chiefly bicarbonate of soda or baking soda.

It is becoming more and more the custom to introduce social features of unusual interest at these meetings, and it is a question whether these are not fully as great a drawing card as the technical papers and discussions. Perhaps they are of even greater value to the members because of the opportunity afforded for interchange of ideas, particularly in view of the fact that the papers, with the discussions, are afterward distributed in book form. At any rate, the unusual attractions arranged for by the committee met with the hearty approval of those in attendance at these sessions.

On Wednesday morning the society enjoyed the novelty of a session on board the *Amerika*, the largest vessel afloat, then at her dock at Hoboken, following which was a trip to the immense new works of the Worthington Hydraulic Works at Harrison, N. J. This is the largest plant in the world devoted to the manufacture of hydraulic machinery and is the outgrowth of the original hydraulic works at Brooklyn, N. Y. The new buildings have an area of about forty acres, the largest of which is the machine shop, 1,000 feet long. The visitors were taken to the plant in a twelve-car train and luncheon was served at the works, but the crowd was so great that the facilities provided were barely sufficient to accommodate those in attendance. Between 800 and 900 people availed themselves of the opportunity to visit this interesting plant.

Another part of the entertainment that was somewhat out of the ordinary and enjoyed by all was the lecture on Wednesday evening by Prof. R. W. Wood, of Johns Hopkins University, who took as a subject the "Photography of Invisible Phenomena." He threw on the screen photographs of many subjects not observable with the naked eye, that greatly interested the spectators. One of the most notable series of illustrations was photography of the sound waves produced by the explosion of a can of dynamite; and so marked were these waves that the shadow caused by them was discernible in the photographs taken by a kinetescopic camera. The illustrations that captured the audience were what Prof. Wood called his "fish-eye" views. If he is correct in his surmises, a fish looking upward to the surface of a quiet pool of water has a range of vision limited only by the horizon; due to the fact that rays of light coming to the surface from points at the horizon are refracted and so reach the eye of the fish. Acting on this supposition, the Professor placed a photographic plate in the bottom of a pail filled with water and in which was a diaphragm supporting a lens. This simple apparatus placed out in the street or a public square produced a negative covering a range of vision of 180 degrees, or in other words from horizon to horizon, and was in the form of a circle with the trees, houses, etc., pointing radially inward.

At the business meeting on the steamship *Amerika* occurred the annual election of officers, Fred W. Taylor being elected president for the ensuing year and Walter McFarland vice-president. Mr. C. W. Hunt reported the progress upon the Engineering Building and announced that the December, 1906, meeting would probably be held in that building. The present house of the society is rated as worth $125,000 and an offer of $115,000 has already been made for it, which places the

The New Engineering Building.

society in good financial condition. The total membership was stated as about 3,000. One of the pleasant events was the election of Charles H. Haswell, the first chief engineer of the United States Navy and the oldest engineer in America, to honor any membership of the society.

A report was presented by the society's committees on standards for machine screws, by George M. Bond, which drew out considerable discussion, much of which was unfavorable. It was contended that many of the sizes chosen did not correspond with wire-gage sizes and Mr. Burlingame, of the Brown & Sharpe Manufacturing Co., suggested that rounded corners be adopted for filister-head screws, instead of the oval form, as it is not necessary to be so careful in counterboring any exact depth in order to have the screws look right. There was also some discussion of the methods of measurement of screw threads, in which considerable diversity of opinion was expressed.

The list of subjects of the technical papers given at the several sessions is as follows: Report of Committee on Standard Proportions for Machine Screws; "Use of Natural Gas Under Boilers," by Jay M. Whitham; "Reinforced Concrete Applied to Modern Shop Construction," by E. N. Hunting; "Measurement of Air Flowing Through Circular Orifices in Thin Plates," by R. J. Durley; "Results of Preliminary Producer Gas Tests, U. S. Geological Survey Testing Plant, St. Louis, Mo.," by R. H. Fernald; Pressure Drop Through Poppet Valves," by Charles E. Lucke; "Test of Elevator Plant, Trinity

Building, New York City," by A. J. Herschmann; "The Realization of Ideals in Industrial Engineering," by H. F. J. Porter.

The paper upon the elevators of the Trinity Building stirred up a small hornet's nest, making it evident that there is more or less opposition to the plunger elevator for high-speed passenger work. The paper by H. F. J. Porter dealt with industrial betterment, and he threw many photographs on the screen showing the work done along these lines and the improved conditions resulting, in many sections of the country.

It has been the custom for many years to have topical discussions at the meetings upon subjects that designers and engineers need practical data upon. The subject for this meeting was "Bearings," and a great deal of material was contributed which, when taken together, will make by far the best treatise on the subject of bearings that has appeared anywhere. Many drawings of ball and roller bearings were shown and data was presented in regard to pressure, durability, metals, lubrication, etc. The discussion of this subject took up nearly the whole of one session, which was prolonged over an hour to give as many as possible an opportunity to speak

Abstracts of the more interesting or valuable papers will be given in the *Engineering Review* of this and succeeding months.

* * *

THE ENGINEERING BUILDING.

A report has been issued by the joint committee representing the Electrical, Mechanical and Mining Engineering Societies in the committee of the Engineering Building. The erection of this building, which is the gift of Andrew Carnegie, is now well under way, at 39th Street, New York. The frame work has reached the fourth story and it is expected that the building will be ready for occupancy next October. The following particulars in regard to the building, taken from the report, are of general interest. The building is to serve the convenience of the three societies, each of which will have one floor for its business offices, committee rooms, etc.

It is expected that the Engineering Building will eventually become the engineering headquarters of America, not only making a home for the three societies mentioned, but affording opportunities for meetings of many other technical societies and providing office room for their headquarters. A sufficient number of offices, therefore, are included in the plans for the accommodation of such societies, and there are to be meeting rooms and auditorium rooms of various capacities adapted to the needs of the different organizations.

The largest of these, designed primarily for the conventions of the three national societies, will accommodate 1,000 persons, this limit being set as the largest number that can be expected to hear clearly the voice of a speaker. The location of this auditorium is on the first floor above the ground, so as to make elevator service unnecessary. On the floor above are two assembly rooms occupying the principal portion of the area, one seating 450 and the other 300. These may be used independently for lecture purposes or one may be made auxiliary to the other and used as a foyer or conversation room; or they may be used in common for social or reception purposes. There are also smaller rooms on the floor, including a kitchen and serving room for light refreshments or luncheon.

On the next floor above are four small lecture halls suitable for ordinary meetings of scientific and engineering societies, seating from 100 to 250 each.

The meeting rooms of all sizes will be fitted for the use of the stereopticon and will be supplied with electric current, compressed air, gas and water, making them complete in every respect for lectures requiring experiments or demonstrations. A freight elevator will serve the building, connecting not only with the office floors so that pamphlets may be received or shipped, but with the floors containing the lecture rooms, so that apparatus and machinery may be delivered in any of these rooms to illustrate a lecture, if desired.

The crowning feature of the building is the provision for the libraries on the upper floors. There will be one common reading room on the top floor with alcoves for the libraries of the individual societies, and the floor below is to be reserved for book stacks with sufficient capacity to accommodate the growth for many years to come. It is the purpose of the societies so to administer the library of each that by bringing them together there shall be a working and reference library of the highest possible value and completeness as respects engineering science and practice. It is believed that by the co-operation of the New York public library on the adjoining block the library in the Engineering Building can be made the most important engineering library of the country and will become the center to which engineers will go for technical information.

The property on which the building is located has 125 feet front and is 100 feet deep. The building laws require that not more than 85 per cent of the lot area shall be occupied and there has accordingly been left a space on all sides of the building, giving it a monumental appearance, and all the rooms will be well lighted. The illustration accompanying this description is from a photograph of the architect's drawing and shows a handsome and impressive structure.

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FREDERICK W. TAYLOR.

New President of the A. S. M. E.

The newly elected president of the American Society of Mechanical Engineers, Frederick W. Taylor, was born in Germantown, Pa., in 1856. He was prepared at the age of eighteen to take a course in Harvard College, having taken a preparatory course in Phillips-Exeter Academy, but at this time

Frederick W. Taylor.

his eyes gave out and he had to give up study, which perhaps was fortunate for the world at large, for it caused him to get an education in another way, bringing him directly in contact with industrial conditions. He served an apprenticeship as a patternmaker in a small steam pump works in Philadelphia, and in order to make rapid progress and get special advantages he worked for less pay than the other apprentices, and in four years finished his apprenticeship both as a patternmaker and a machinist. When he had finished his apprenticeship, in 1878, times were so dull that he could not get work at his trade so he went to work in the machine shop of the Midvale Steel Co. as a laborer. Here he was rapidly promoted, being successively shop clerk, tool room foreman, gang boss, assistant foreman and general foreman of the machine shop. Next he became master mechanic in charge of repairs and maintenance of works; then chief draftsman, and in 1884 chief engineer of the works. Thus, in the short period of six years he worked up from laborer to chief engineer. But with all his work with the Midvale Steel Co. he found time for home study. Soon after he went there he felt the need for a more complete engineering education, and in 1880 began study at night in the engineering course of Stevens Institute in addition to his work of ten hours per day. He passed all his examinations and graduated with a degree of mechanical engineer in 1883. The sobriquet "Speedy Taylor," which he

afterward earned with the Bethlehem Steel Co., seems to have been well merited in his early career.

Leaving the employ of the Midvale Steel Co. in 1890, he organized and managed some pulp mills, and after accomplishing this work he has since devoted his entire time to the organizing of various manufacturing establishments. Mr. Taylor's most important engineering work consists of the design of a great part of the plant and machinery of the Midvale Steel Co., including the largest steam hammer running in this country. This hammer has been working steadily and with very little repair since 1890. For twelve years it made all of the large gun forgings sold by the Midvale Steel Co. to the United States government, competing during this time, successfully, with the large and expensive forging presses used by the Bethlehem Company. This hammer was built on an entirely new and original design made and patented by Mr. Taylor, and in this connection it may be mentioned that he has taken out something over fifty patents. His name, however, in the engineering world is chiefly identified with his system of shop management and the Taylor-White process of treating tool steel, which, perhaps, has worked the greatest revolution in machine shop production of any discovery of recent times. In shop management he endeavored to reduce it to an art and his system is now used successfully in many establishments covering a large variety of work, the principal concerns being the Midvale and Bethlehem steel companies. It was in connection with the latter that he and Mr. Maunsel White developed the Taylor-White process of heat treatment for air-hardening steels by which they were made capable of standing cutting speeds much higher than had heretofore been possible.

He has presented several important papers before the A. S. M. E., among which are the following: "A Comparison of Various Fuel Gases," "Notes on Belting" (describing a practical experiment on the treatment and durability of all belts in a machine shop extending through a period of nine years), "A Piece Rate System," and "Shop Management." He also published this year, together with Mr. Sanford E. Thompson, a book of five hundred pages on "Concrete, Plain and Reinforced."

That Mr. Taylor is not wholly wrapped up in his engineering work is indicated by the fact that he won the first double championship at Newport and this he considers his most important (*sic*) achievement.

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THE SHIFTING OF THE COTTON INDUSTRY FROM NORTH TO SOUTH.

The early mechanical history of New England and the work of her early mechanics is largely concerned with the development of the cotton industry. The manufacture of cotton goods has been the foundation of much of the industrial success of this section, and the gradual shifting of the center of the industry from the New England States to the cotton states of the South, where, it must be admitted, it rightly belongs, will be a serious blow to the pioneer States in this line of manufacture.

The latest move toward the grounding of the industry in the South is an important water power development on the Yadkin River, near the town of Whitney, North Carolina. There is here available a fall of 129 feet and a volume of water sufficient to develop 54,000 horse power. Six water turbines are to be installed, direct-connected to alternating-current generators of 5,000 kw. capacity. The generators will operate at 11,000 volts, a pressure that will carry a current a distance of 12 miles, with a loss of only 2 to 4 per cent. For greater distances there will be transformers to step the voltage to 30,000 and to 60,000 volts, the latter for transmission to points at a distance of 80 to 100 miles. Within 80 miles of the plant there are now said to be 278 cotton mills, all of which, from the smallest to the largest, can use this power and each of which can thus derive the benefit of the economical production of power on a large scale, such as could be realized only with steam plants of immense size, were steam to be used for power.

It is estimated by the engineers that when the whole 54,000 horse power is taken up, additional power can be developed by other installations above and below the present one on the same river.

The question of power is a serious one for New England industries. While the water power furnished by her swift-running streams has been the means of the establishment of many factories, this power must usually be developed on a small scale, compared with the immense plants that are now coming into use on some of the larger rivers in other sections, in connection with electrical transmission. Small plants mean a large investment for the power developed, and this fact, together with the necessity for steam heat in our northern climate during eight months of the year, has led many engineers to question whether, after all, it was not cheaper to use steam for power during the whole twelve months.

Another reason why New England is at a disadvantage with the South is because of the wage condition. When Samuel Slater started his first water spinning mill at Pawtucket, R. I., in 1790, there began the dawn of a new era in industrial conditions. It meant the shifting of an important industry from the home to the factory. The spinning and weaving in the home were done by women, and they followed the industry to the factory and have since formed a considerable portion of the help employed in cotton factories. It is a law of economics that the money earned by the average family bears a fixed relation to the value of the commodities consumed by the same unit, and this holds whether several members of the family are employed, or the head of the family only is at work. That is, in industries where only men are employed, the wages per family amount to practically the same as in industries of a similar grade where several members of the family are earners. The consequence is that the prevailing rate of wages in the cotton industry has been low and there is bound to be more or less pressure brought to bear by the employers to secure wage rates commensurate with those in other lines of industry. In the South, however, where the prevailing rates are lower, as a whole, this trouble is not likely to be encountered to so great an extent.

In the face of these conditions the Southern mills have started and some of them are now preparing to take advantage of one of the large water powers from which power can be transmitted electrically and utilized at less than the cost for steam power, which, with the cheap Tennessee coal, is much less than in the North. It would seem that the new plant at the Yadkin River will, if successfully completed, constitute an important step in the development of the mechanical history of the South; and possibly in the undoing of history in the North.

* * *

The American Woolen Co. is building at Lawrence, Mass., what will be the largest worsted mill in the world, to eventually employ 5,000 hands. A novel feature of the plant will be the installation of an escalator, or traveling staircase, for carrying employees to and from the various floors. The escalators are to be installed in a special building situated between the wings of the factory proper. Two of these will run in parallel from the second to the fourth floors, it being contemplated that the employees will either walk down from the fourth to the third or ascend by ordinary stairs from the second to the third floor. One escalator will run from the fourth to the fifth floor and one from the fourth to the sixth. It is believed by the management of the American Woolen Co. that this installation will not only add to the comfort and convenience of the employees, a large proportion of whom are women, by making it unnecessary for them to go up or down long flights of stairs, especially when tired out by a day's work, but that it will also increase their efficiency to a considerable extent. The escalators will run in a downward direction at the beginning of the noon hour and at the closing of the mill at night, and also in the event of fire. At other times they will run in an upward direction. This type of traveling staircase is built by the Otis Elevator Co., New York City, and the fact that it is reversible and will run in either direction apparently makes it unusually well adapted to factory use. It is estimated that if elevators were installed it would require one hundred of them of ordinary size to carry the same number of employees to the different floors within the same length of time that the escalator will carry them.

THE CONRADSON SPEED BOX.

A variable speed device has recently been patented by C. M. Conradson, mechanical engineer, New York, and is now being developed as a speed box for driving engine lathes. The device combines a number of features that are of unusual interest because of their novelty. The speed changes are obtained in steps by means of different combinations of gearing, but unlike other gear devices the changes may be made rapidly, while power is being transmitted, without the shock or danger of breakage incident to speed boxes having clutches or slip gears of the usual type.

The mechanism of the Conradson speed box consists of one or more sets of gearing, each of which has a clutch of peculiar design, all of the sets being duplicates of one another. These units, consisting of the clutch and the train of gears, are inclosed within a cylindrical casing and are placed in a row, one following the other and concentric with the same axis. The illustration, Fig. 1, shows a speed box having two units, which will give four changes of speed. Power is transmitted from the receiving pulley at the left to the pinion at the extreme right which delivers power to the lathe or other machine that is to be driven. There are three separate shafts, *A*, *B*, and *C*, all having the same axis. The first shaft connects the driving pulley with the first train of gears; the second connects the two trains of gears; and the third, the last train with the pinion at the right. When all the gears are locked they become inoperative so far as changing the speed is concerned, and the three lengths of shafting, *A*, *B*, and *C*, rotate as one piece, the pinion at the right making the same number of turns per minute as the pulley at the left. With the first train of gears in operation and the second train of gears locked, a second speed is obtained; with the second train in operation and the first locked a third speed, and with both trains in operation a fourth speed is obtained.

On the right end of shaft *A* is keyed pinion 1, which, when permitted to do so, drives through the back gears 3 and 4, (as well as through back gears located oppositely at the bottom of the drawing, but which for simplicity will not be referred to), to the pinion 2 keyed to the left end of the shaft *B*. The back gears 3 and 4 rotate as one piece upon a pin carried by disks *D* and *E*, which turn loosely upon shafts *A* and *B* respectively. When these disks are prevented from rotating it will be evident that the back gears will operate to reduce the speed of shaft *B* after the usual manner of back gearing. On the other hand if these disks are made to rotate with shaft *A* the only effect will be to lock shaft *B* with shaft *A*, and so produce no change in velocity ratio. This control of the action of disks *E* and *D* is accomplished by means of a clutch of peculiar and interesting construction, which acts exactly the opposite from the ordinary clutch. That is, when the operator makes a movement corresponding to that of "throwing in" the ordinary clutch, he throws this clutch out of action; and it is thrown into action when he makes a movement corresponding to the release of the ordinary clutch, this throwing in being accomplished by the positive action of the mechanism itself.

The clutch consists of three essential elements: First, conical friction surfaces; second, clutch teeth which are beveled or cam shaped so that when they are in mesh there will be a tendency for these cam surfaces to crowd two parts of the clutch apart. The third element is a split ring having beveled surfaces which bear against corresponding surfaces of the clutch and draw the same two parts of the clutch together.

In Fig. 1 *G* is a conical disk fast to shaft *A*, and *F* is a ring free to slide in an endwise direction, having beveled surfaces as indicated. These constitute the first element or the friction part of the clutch. At *f* are the bevel clutch teeth which mesh with corresponding teeth on the face of carrier *D*. The ring *F* is forced to the left against the conical surface of *G* by means of the spiral spring shown which acts as a "teaser." That is, suppose the conical disk *G* to rotate and the ring *F* to be forced against the conical surface of the disk by means of the spring. The ring *F* will evidently tend to turn with the shaft *A* and its disk *G*, but the carrier *D* will tend to lag behind, inasmuch as it is connected, through the gearing, with the driven part of the mechanism. The second element, which consists of the clutch teeth *f*, therefore goes into action and forces the ring *F* against the friction surface of *G*, with the result that it turns with *G* and, because of the clutch teeth *f*, carries with it also the carrier *D* and its gearing and thus compels shaft *B* to rotate with shaft *A*. In other words *A* and *B* are locked together and the greater the power transmitted the more positively will the elements be locked because of the crowding action of the clutch teeth *f*.

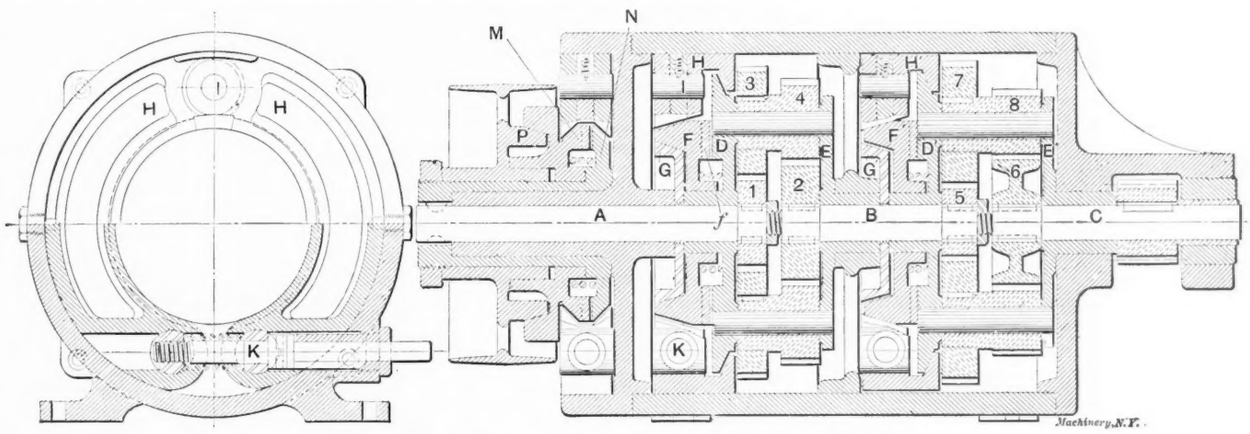


Fig. 1. Longitudinal Section through Conradson Speed Box of Two Units.

Now, if it is desired to throw out this clutch and allow shaft *A* to drive shaft *B* through the back gears, thus reducing its speed, the third element, *H*, is brought into play, which consists of two segments of a ring pivoted at *I* and drawn together at the bottom by the screw *K* which is under control of the operator. These segments of the ring are fixed to the casing and have beveled surfaces which bear against the bevel on the outside of ring *F*, and on the periphery of carrier *D*. By drawing the two segments together at the bottom, the sliding ring *F* and the carrier *D* are crowded together (as shown in a second mechanism at the right), thus releasing the friction surfaces of *G* and *F*. Referring now to the mechanism at the right, which is drawn with the several parts in the positions they would assume under the above conditions, we see that, while the ring *F'* does not bear against *G'*, it does bear against the corresponding conical surfaces of the segments, which thus form a brake tending to prevent the rotation of ring *F'*. In this case, however, the carrier *D'* tends to continue in motion, owing to the power that is being transmitted through the train of gears, and the clutch teeth act to force ring *F'* solidly against the friction surface of the segments *H'*. The result is that the carrier *D'*, and with it, of course, *E'*, are locked so that they cannot move and power then is transmitted through gears 5, 7, 8 and 6 to the shaft *C*.

It will be noted that in each case the tendency of the cam teeth of the clutch is to crowd the sliding ring to the left, but in one instance it forces it against the rotating piece so that it must travel with it, causing the train of mechanism to revolve about the common axis; while in the second case it is forced just as positively against the stationary surface of the

brake, which prevents the train of mechanism from revolving about the axis. Another important feature is that all the gears are running only at the lowest speed of the last or driven element; part of the gears at intermediate speeds; and none of them at the highest speed, when the speed is 1 to 1.

The driving pulley *P* transmits power to the shaft *A* through a clutch similar in operation to the clutches just described.

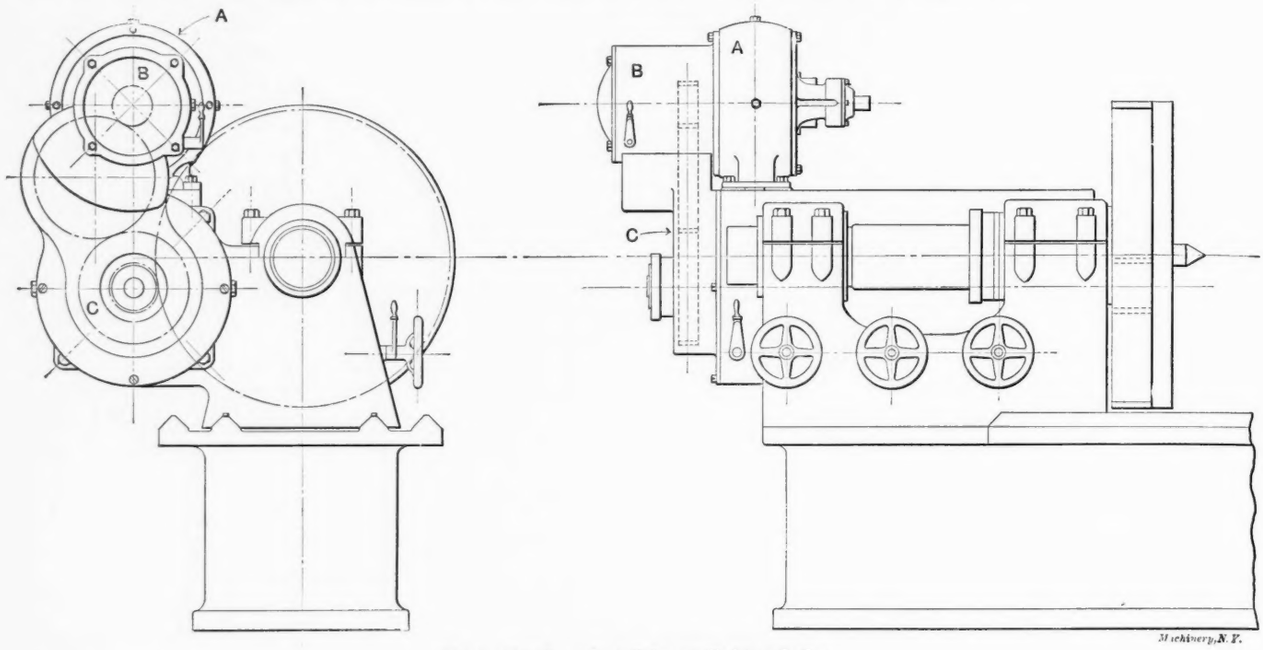


Fig. 2. The Conradson Drive applied to a Lathe.

The sliding element *M* comes in contact with the bevel surface *P* of the pulley and the element *N* is keyed to the shaft *A*. There are clutch teeth between the pieces *M* and *N*. The segments of the ring which form the brake draw the elements *M* and *N* together, releasing the clutch just as in the previous case. When, however, the segments of the ring are separated, the clutch is thrown in contact with the conical surface of the pulley by the resistances of the mechanism.

Fig. 2 shows an arrangement of the device for driving an engine lathe by means of a constant speed motor. The main speed box is located back of the spindle and drives the latter by a gear on the face place. This illustration shows a three-unit speed box, each unit being controlled by a hand wheel at the front of the head stock. There are thus eight combinations possible, giving eight changes of speed with this one speed box. There is also a one-unit speed box attached directly to the motor frame at *B*, giving two speed changes, which, taken in connection with those of the main speed box, provides sixteen changes of speed. The brake ring of the motor speed box is operated by the lever shown at the left-hand end and there is a clutch operated by a similar lever at the left end of the main speed box. The hand wheels have been adopted for controlling the speeds in machine tool work, and are probably as convenient for this purpose as any arrangement. In automobile work, however, it will be desirable and quite possible to arrange either a sliding or a rotating cam that would throw in the successive units in their proper order by the movement of a single lever or one hand wheel. This means if a car were running at say 40 miles per hour and it was desired to slow down, the change could be brought about instantly by shifting the position of the speed through the successive steps.

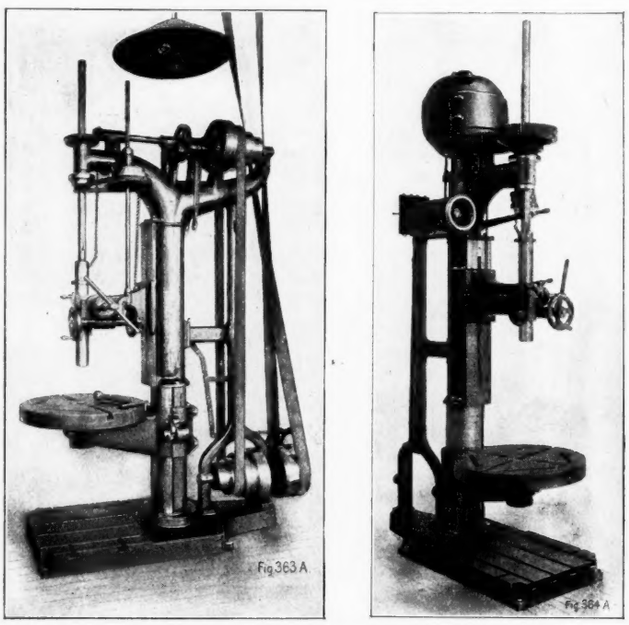
The Conradson speed box is being developed and placed on the market by the Industrial Engineering Co. of America, New York City, and a lathe is now under construction to which the speed box is to be attached.

* * *

A trackman on the Manhattan Elevated railroad recently dropped a track wrench across the third-rail and a track rail thus forming a short circuit which badly burned the unfortunate laborer, fused out a section of the track and blocked traffic for half an hour. If the damage to the men and delays to traffic because of this foolish construction could be accurately computed we suspect that it would figure out several times the alleged great cost of protecting the third-rail of this installation but cent-wise-and-dollar-foolish methods are responsible for some queer engineering.

THE SIMPLICITY OF THE ELECTRIC DRIVE.

The two cuts below show a 30-inch drill press as it was before and after being changed to a motor drive. The drill was formerly belt driven by the usual loose pulley and cone pulleys mounted in the frame of the machine at the rear, the upper cone pulley driving the vertical spindle through bevel gears. These shafts, cone pulleys, belts, and bevel gears, were



Before and After the Application of a Motor Drive.

all removed and a Crocker-Wheeler, vertical type, motor substituted, the result being a considerable loss in complexity of mechanism, and a corresponding gain in ease of handling and general appearance. The variations in speed are obtained solely through the motor, which is supplied with current from a four-wire multiple voltage system. The spindle speeds range from 51 to 276 revolutions per minute.

HAND REAMERS.

H. D.

Hand reamers probably are amongst the most difficult and particular tools to make and manufacture. I have seen and tried many hand reamers manufactured by firms considered to be leading in the making of small tools. However, no regard or attention seems to have been given to some of the most essential points in the making of these tools. As, of course, everybody knows, it is absolutely necessary when making a *good* hand reamer to take into consideration that the reamer is expected to produce: 1. a smooth hole; 2. a straight hole; and 3. a round hole.

If we now first consider what means are generally used for making reamers that will produce a smooth hole, we will find that three ways have been tried with more or less success. The first and earliest means used to prevent chattering were to make an odd number of flutes in the reamers but this has been almost entirely discarded on account of the difficulty in measuring the diameter of such reamers. At present some manufacturers, in order to overcome the vibrations which spoil the smoothness of the hole, make their reamers with spiral flutes. This, although partly overcoming the difficulty referred to, has several serious disadvantages. In the first place such a reamer is more difficult and more expensive to flute, not to mention the difficulty of giving such a reamer the proper relief. In the second place a reamer fluted in such a way has the disadvantage of either working forward or resisting, depending on whether right-hand or left-hand spiral flutes have been given to the reamer in question. It may be noted that it is preferable to make right-hand reamers of this description with left-hand spiral flutes and *vice versa*, which will prevent the reamer from working forward. Someone might think that the working forward of the reamer (to a certain extent depending upon the amount of spiral given to the flutes) would rather be an advantage, and so it would, provided that the forward motion could be on the one hand perfectly uniform, and on the other hand small enough to advance the reamer a very limited distance for each revolution. This result, however, can be obtained in a very much simpler and cheaper way by using straight flutes and threading the reamer on the point for a short distance. The advance of the reamer in this case will of course be governed by the pitch of the thread. The outside diameter of the threaded portion must obviously be slightly smaller than the diameter of the reamer itself.

Returning to our original consideration in regard to the means employed to prevent vibration, the third way used is to "break up the flutes," which means that the cutting edges are not equally spaced, although the reamer then is given an even number of flutes. This ununiformity in spacing need not be greater than to permit a gaging of the diameter of the reamer over two opposite cutting edges that will be correct for all practical purposes. The "breaking up of the flutes" is the simplest and most effective way to obtain the result wanted, viz., a smooth nole. Leading manufacturers are commencing more and more to manufacture their reamers in this manner.

The second consideration which was mentioned above as necessary for a good reamer was its capability of producing a straight hole. This is the principal point to which I referred in the beginning of my article which seems to have been wholly disregarded by manufacturers of reamers. No reamer will produce a straight hole unless it is properly started, and no reamer will start properly unless it is properly guided. It is obvious that even with the most extreme care, and handled by the most experienced man, a reamer without a guide will make the hole slightly tapered, and too large at the end where the reamer first enters the work.

The way hand reamers are generally made for the market is to simply taper the point for a certain distance up, leaving nothing to steady or guide whatsoever. This is not right. Instead a fluted cylindrical portion of the end of the reamer should be left without relief, and this part should be so much less in diameter than the reamer itself as is practical for various metals to be cut with the reamer. As this amount is very small, and is left entirely to the judgment of the manufacturer, the practice of making reamers with guides slightly smaller than the diameter of the reamer would prevent the user from misusing and abusing the tool as he cannot use it to remove a greater amount of metal than the reamer is intended for, because the guide will not enter a hole that is not roughed out sufficiently large before hand reaming. When using a reamer with a tapered point it is usually possible to enter and start the reamer in holes so much smaller than the finished size as to seriously injure and even spoil it, by trying to make it perform a duty for which it was not intended, this being possible because the taper is by most manufacturers made so large as to permit such a thing.

The third consideration referred to above, and essential to a good reamer, with its capability of producing a round hole. Most of the reasons set forth in the first part of the article treating the possibilities of getting a smooth and a straight hole reappear here, and it may well be repeated that unevenly

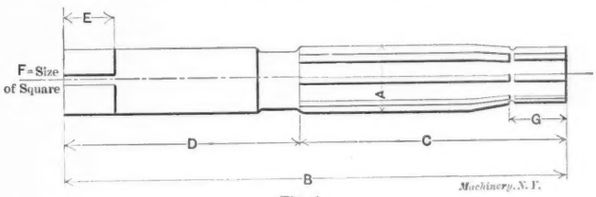


Fig. 1.

TABLE I. PROPORTIONS OF HAND REAMERS.

Diam.	Total Length.	Length of Flute.	Length of Shank.	Length of Squared Part.	Size of Square.	Length of Guide.
A	B	C	D	E	F	G
1/16	2 3/16	7/8	1 5/16	7/32	3/64	3/16
1/8	2 5/8	1 1/4	1 1/4	1/4	3/32	1/4
3/16	3 1/16	1 3/8	1 11/16	9/32	9/64	1/4
1/4	3 1/2	1 1/2	1 5/8	5/16	3/16	1/4
5/16	3 15/16	1 7/8	2 1/16	11/32	3/64	3/8
3/8	4 3/8	2 1/4	2 1/4	3/8	3/32	1/2
7/16	4 13/16	2 3/8	2 1/16	13/32	7/64	7/16
1/2	5 1/4	2 5/8	2 5/8	7/16	3/16	1/2
9/16	5 11/16	2 7/8	2 13/16	15/32	9/64	9/16
5/8	6 1/8	3 1/8	3	1/2	3/16	5/8
11/16	6 9/16	3 3/8	3 3/16	17/32	9/64	5/8
3/4	7	3 5/8	3 3/8	9/16	3/16	11/16
13/16	7 7/16	3 7/8	3 9/16	19/32	9/64	3/4
7/8	7 7/8	4 1/8	3 3/4	5/8	3/16	13/16
15/16	8 5/16	4 3/8	3 15/16	21/32	9/64	13/16
1	8 3/4	4 5/8	4 1/8	11/16	3/16	7/8
1 1/16	9 3/16	4 7/8	4 1/16	23/32	9/64	15/16
1 1/8	9 5/8	4 15/16	4 7/16	3/4	3/16	15/16
1 3/16	9 9/16	5 1/16	4 1/2	25/32	9/64	15/16
1 1/4	9 3/4	5 3/16	4 1/16	13/16	3/16	1
1 5/16	9 15/16	5 5/16	4 5/8	27/32	9/64	1 1/32
1 3/8	10 3/8	5 3/8	4 3/4	7/8	3/16	1 1/16
1 7/16	10 5/16	5 1/2	4 13/16	29/32	9/64	1 3/32
1 1/2	10 1/2	5 5/8	4 7/8	15/16	3/16	1 1/8
1 9/16	10 11/16	5 3/4	4 15/16	31/32	9/64	1 3/32
1 5/8	10 7/8	5 13/16	5 1/16	1	3/16	1 3/16
1 11/16	11 1/16	5 15/16	5 1/8	1 1/32	9/64	1 3/32
1 3/4	11 1/4	6 1/16	5 3/16	1 1/16	3/16	1 1/4
1 13/16	11 7/16	6 3/16	5 1/4	1 3/32	9/64	1 9/32
1 7/8	11 5/8	6 1/4	5 5/16	1 1/8	3/16	1 5/16
1 15/16	11 13/16	6 3/8	5 7/16	1 5/32	9/64	1 11/32
2	12	6 1/2	5 1/2	1 3/16	3/16	1 3/8
2 1/16	12 3/16	6 5/8	5 5/16	1 7/32	9/64	1 25/64
2 1/8	12 3/8	6 11/16	5 11/16	1 1/4	3/16	1 7/16
2 3/16	12 9/16	6 13/16	5 3/4	1 9/32	9/64	1 15/32
2 1/4	12 3/4	6 15/16	5 13/16	1 5/16	3/16	1 1/2
2 5/16	12 15/16	7 1/16	5 7/8	1 11/32	9/64	1 17/32
2 3/8	13 1/8	7 1/8	6	1 3/8	3/16	1 9/16
2 7/16	13 5/16	7 1/4	6 1/16	1 13/32	9/64	1 19/32
2 1/2	13 1/2	7 3/8	6 1/8	1 7/16	3/16	1 5/8
2 9/16	13 11/16	7 1/2	6 3/16	1 15/32	9/64	1 21/32
2 5/8	13 7/8	7 9/16	6 5/16	1 1/2	3/16	1 11/16
2 11/16	14 1/16	7 11/16	6 3/8	1 17/32	9/64	2 1/64
2 3/4	14 1/4	7 13/16	6 7/16	1 9/16	3/16	1 3/4
2 13/16	14 7/16	7 15/16	6 1/2	1 19/32	9/64	2 7/64
2 7/8	14 5/8	8	6 5/8	1 5/8	3/16	2 1/8
2 15/16	14 13/16	8 1/8	6 11/16	1 21/32	9/64	2 13/64
3	15	8 1/4	6 3/4	1 11/16	3/16	2 1/4
3 1/16	15 3/16	8 7/16	6 15/16	1 3/4	3/16	2 11/64
3 1/8	15 3/8	8 11/16	7 1/16	1 13/16	3/16	2 7/32
3 3/16	15 9/16	8 7/8	7 1/4	1 7/8	3/16	2 15/64
3 1/4	15 3/4	9 1/8	7 3/8	1 15/16	3/16	2 1/2
3 5/16	15 15/16	9 5/16	7 9/16	2	3/16	2 17/64
3 3/8	16 1/8	9 9/16	7 11/16	2 1/16	3/16	2 9/32
3 7/16	16 5/16	9 3/4	7 7/8	2 1/8	3/16	2 19/64
4	16	10	8	2 1/8	3/16	2 5/16

spaced (broken up) cutting-edges, and a guide, nicely fitting in the hole to be reamed, are the most essential points necessary to produce the results wanted.

It will also be necessary to remark that giving too much or too little relief to a reamer will tend to produce unsatisfactory results. Too much relief invariably causes a reamer to chatter. Too small relief, again, will make the reamer very short lived, and will cause it to bind in the hole. In this connection it might be mentioned that the flat relief, although mostly used, is not the most desirable or the ideal one, because the cutting edge is not properly supported. In the writer's opinion the relief producing the best result is the one drawn in full lines in Fig. 2. The difference between this relief and the flat is obvious from the cut, where the latter

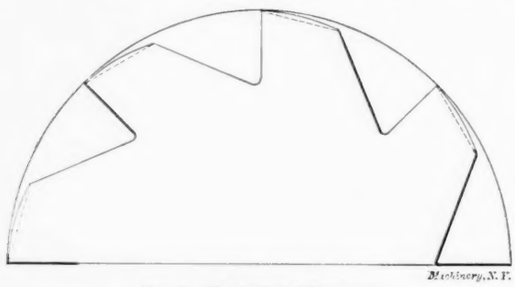


Fig. 2. The Relief of Reamers.

has been shown in dotted lines. This special relief, called eccentric relief, to my knowledge being used only by two prominent tool manufacturers, tends to add to the reamer's capability of producing a smooth hole.

Formulas for the principal dimensions of hand reamers, are given, together with a table figured according to the formulas given. For the diameter of the shank no figures are given in the table, as on any size reamer the general rule to make the shank very slightly below (0.001 to 0.002 inch) the diameter of the reamer may be adopted. The part of the shank which is squared should be made enough smaller in diameter than the shank itself, so that when applying a wrench no burr may interfere with the reamed hole.

Figures for the diameter of the guide will not be found in the table as here no general rule could be given. For different metals it is obvious that different amounts should be left for the reamer to cut. As a rule for all around work the writer would recommend to make the guide (viz., the amount to ream) from 0.005 to 0.007 inch smaller than the reamer for diameters up to 1 inch, and from 0.008 to 0.012 inch smaller for diameters from 1 to 3 inches. At the upper end of the guide there is a tapered portion (shown exaggerated in the cut) extending from about ⅜ to ½ inch.

In all formulas the diameter of the reamer has been considered as the starting point. In the formulas:

A = diameter of reamer.
B = total length.
C = length of flute.
D = length of shank.
E = length of squared part.
F = size of square.
G = length of guide.

For reamers from 1/16 to 1 inch diameter the following formulas are used:

$B = 7A + 1\frac{3}{4}$
$C = 4A + \frac{5}{8}$
$D = 3A + 1\frac{1}{8}$
$E = \frac{1}{2}A + 3/16$
$F = \frac{3}{4}A$
$G = \frac{3}{4}A + \frac{1}{8}$

For reamers from 1 1-16 inch to 4 inches diameter, the following formulas are used:

$B = 3A + 6$
$C = 1\frac{3}{4}A + 3$
$D = 1\frac{1}{4}A + 3$
$E = \frac{1}{2}A + 3/16$
$F = \frac{3}{4}A$
$G = \frac{1}{2}A + \frac{3}{8}$

In the table some dimensions are given in even sixteenths when the formulas give uneven values.

As was mentioned before, the best way to obtain a good hand reamer is to have the cutting edges irregularly spaced. This difference in spacing may be made very slight. The manner in which it is usually done is to move the index-head, in which the reamer is fixed, a certain amount more or less than would be the case if the spacing were regular.

I have added a table below to be used as a guide for those not familiar with doing work of this kind, which gives the amount that the index-head should be moved more or less than would be the case for even spacing. The figures designate the number of holes to move in the certain index-plate used in each special case. It is, of course, understood that this table is only given as an example of how tables of this kind may be worked out, and there are, of course, an unlimited number of variations, provided that the "break" is large enough to serve the purpose.

* * *

One of the largest grain elevators in the world, the Canadian Pacific Railroad elevator D at Fort William, having a capacity of nearly 3,000,000 bushels, collapsed as a result of defective design. The subject of grain pressure in big bins is peculiarly interesting. It does not follow the law of fluid pressure, but the friction of the sides makes the vertical pressure on the walls a very important factor. With the old construction of wooden bins the vertical strength of the bins was always sufficient to take care of the vertical stress if made strong enough to resist bursting pressure. Not so, however, with steel bins, for they have much greater bursting strength than collapsing strength when loaded from above. Mr. J. A. Jamieson has made this the subject of exhaustive research and has deduced formulas for determining the vertical pressure. His work in this line was the subject of a paper read by him before the Canadian Society of Civil Engineers which was briefly abstracted in the March, 1904, issue of MACHINERY.

TABLE II. FOR IRREGULAR SPACING OF FLUTES IN REAMERS.

Number of flutes in reamer	4	6	8	10	12	14	16
Index circle to use	41	39	47	47	39	49	20
Before Cutting.	Number of Holes in Index Plate to move Spindle more or less than for Regular Spacing.						
2d flute	8 less	4 less	3 less	2 less	4 less	3 less	2 less
3d "	4 more	5 more	5 more	3 more	4 more	2 more	2 more
4th "	6 less	7 less	2 less	5 less	1 less	2 less	1 less
5th "	.....	6 more	4 more	2 more	3 more	3 more	2 more
6th "	.....	5 less	6 less	5 less	4 less	1 less	2 less
7th "	.....	.....	2 more	3 more	4 more	3 more	1 more
8th "	.....	.....	3 less	2 less	3 less	2 less	2 less
9th "	.....	.....	.....	5 more	2 more	1 more	2 more
10th "	.....	.....	.....	1 less	2 less	3 less	2 less
11th "	.....	.....	.....	.....	3 more	3 more	1 more
12th "	.....	.....	.....	.....	4 less	2 less	2 less
13th "	.....	.....	.....	.....	.....	2 more	2 more
14th "	.....	.....	.....	.....	.....	3 less	1 less
15th "	.....	.....	.....	.....	.....	.....	2 more
16th "	.....	.....	.....	.....	.....	.....	2 less

LETTERS UPON PRACTICAL SUBJECTS.

A REAMER FOR ACCURACY AND SPEED.

Editor MACHINERY:

To those interested in the manufacture of small steel parts, the following may prove of interest: It has been required of me to produce, in large quantities, parts of machines, the all-important point in their usefulness being accuracy of holes, perfect in size and very smooth, with a free working fit on a standard plug gage, while a gage 0.0003 inch larger must not enter. This quality of work has to be kept up uniformly, and not with here and there a lot with holes 0.0005 to 0.001 inch larger. The reamer shown in two views, Figs. 1 and 2, has been filling the bill for four years; it is extremely simple to make and inexpensive.

To make a reamer of this type use drill-rod about 0.002 inch larger than the hole desired; cut to the length required and round cutting end as shown, finishing very smooth; then

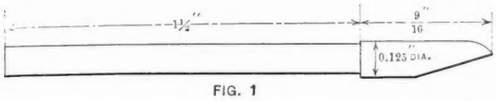


FIG. 1

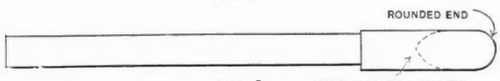


FIG. 2 VERY HARD AND SMOOTH

Machinery, N. Y.

A Reamer for Holes in Thin Plates.

harden, dipping the reamer into mixture of one-third muriatic acid and two-thirds water; after this warm the tool to a degree that will sizzle water when dropped on it. The reamer *must* be hard and the above mixture will make it so. Lap with flour emery to size, using a reliable lap to produce a high finish and polish the round end nicely. Grind a flat diagonally across the point as shown at *A*, and the reamer is ready to use. When dull, grind as before.

This reamer is practical for reaming 3-16-inch holes and smaller in stock 1-16-inch thick and less, and will do good work in 5-32-inch stock. I have used one of these reamers in 0.050 inch steel stock for six months (continual use) with the work still up to gage and handling 2,500 pieces per day.

All work must be rough-reamed first, leaving not over 0.002 inch to finish and plenty of good oil must be used on every piece. If used dry for one hole only, the reamer may cut large from metal being burned on, though a glass may be required to see it. This may be carefully stoned off without injury to tool.

L. S. B.

A MECHANIC OF RESOURCE.

Editor MACHINERY:

Speaking of the various ways of applying for a "job" as a machinist journeyman and keeping it, reminds me of a man of my acquaintance, who walked in the shop one day about 8 o'clock in the morning and asked the foreman to give him a trial as a first-class all-around machinist, whereupon the foreman asked him what he could do, and he replied, "I learned the trade in a one-horse job shop, and I can do anything from turning a handspring down to splitting a corkscrew."

The foreman (with an inward chuckle) said, "I will just try you once for fun. When can you begin?"

"I am ready now," the man replied.

"But where are your tools?" inquired the foreman.

"Here they are," he replied, producing a two-foot rule, a one-pound hammer, and a pair of ordinary (firm-joint) outside calipers.

"Well, you may go and set up that portable engine frame on the 60-inch planer over there, and plane it up; here are the blueprints," the foreman replied.

To the surprise of us all he used his outside calipers for a surface gage, also as a scratch gage, by using some smooth wooden blocks in connection with it. Then he needed a hermaphrodite to strike some centers, etc., so he picked up a piece of stiff wire, sharpened it, and with a piece of string tied it to one of the caliper legs, and made it answer for that tool. A little later he wanted a divider, so he sharpened another piece of wire and tied it to the other leg, and he had a passable divider. After planing off the surface for the steam chest cover he wanted a depth gage for the valve seat. This he made by setting the washer and one point of the caliper on the first surface and using the other leg to swing and get his depth, thus a depth gage was made. A little later on he wanted an inside caliper to get an inside measurement, so by sliding the caliper points past each other he produced the desired tool. Then the thickness of the cylinder wall came up for discussion, and the man picked up a two-inch gage block that happened to be handy and by laying it on the cylinder outside, he set his outside calipers to the block and bore, so by subtracting the two inches from it he had the thickness, the same as though he had used an expensive transfer caliper. A few minutes later he discovered a slotted head screw working out of the planer tool-head, so he used his calipers for a screwdriver to tighten it up with. When he came to plane off the flange for bolting to the steam pipe he wanted to lock the tool-head to the cross-rail; he could not find the wrench to fit the setscrew, so he shoved the caliper legs together until they fitted the setscrew and thus used it as a monkeywrench.

All this took place before noon, and during the noon hour the "new man" explained to us that he had used that particular pair of calipers for many years, and also showed us how he had used it for a height gage, a draftsman's curve, bevel gage, thickness gage, thread tool gage, drill grinding gage, tap wrench, vise, counterbalance weight, ice tongs, etc., for many other odd jobs too numerous to mention.

As the days and weeks wore on we all came to respect this man very much for his great ability to cope with any job or occasion that presented itself. Nevertheless I do not exactly fancy the salute he gave the foreman when he was asking for a position, and I dare say that if any other man had asked with the same words he would have been flatly refused.

My object in telling you about this is to show many of your readers how the competent mechanic has almost no limit to the tools he has at hand. I considered that man to be a good sample of mechanics, and the word *mechanic* infers a great deal more than some people imagine; it certainly means more than machinist, because a great many machinists are not *mechanics*.

STEEL.

THE "SHORT" COUPLING.

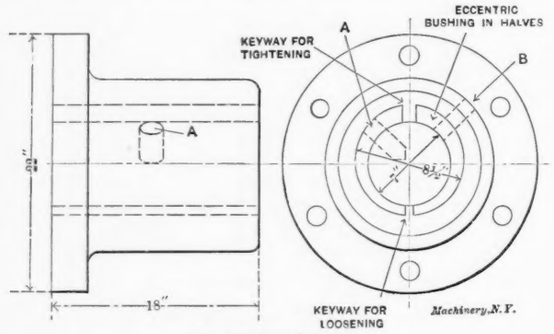
Editor MACHINERY:

About thirty-five years ago Mr. E. G. Short, of Carthage, N. Y., invented and, I think, patented a coupling for shafting. As the company organized for its manufacture has long since gone out of business and the patent has expired, I can now tell of an experience with it without appearing to advertise it. I once witnessed a very severe test of the power of this coupling to hold and drive without slipping, and because of the ease with which it may be put on shafting in the mill without removing it from position I think that some of the readers of MACHINERY will be interested in a description of the coupling and the incident referred to.

The place where the coupling was applied, and one that I consider was a hard test of its efficiency, was in a large steam sawmill driven by a 400 horsepower engine. The mill was able to saw a boat-load of lumber in twenty-four hours. The engine was directly connected to the lineshaft, which extended throughout the entire length of the mill, driving four gate saws, an edger, lath mill and butting saws. Upon starting up the mill one spring it was discovered that the coupling connecting the engine shaft to the lineshaft was loose; it had worked loose the previous season and had been repaired by a turned bolt, driven tightly through a drilled and reamed hole in both shaft and coupling, and riveted over on each end. This job had worn loose again, but when the mill was started in the spring the demand for lumber was so great that the owners wanted to start without taking time for removing the shaft, as seemed necessary to give it a thorough repair. They thought that the logs in the pond would soon be cut up and then there would be a dry time when the lineshaft repairs

could be made without loss of sawing, but the water remained high all summer, and no available time came. The shaft became so badly worn that it was absolutely necessary to tighten it, and the first Saturday night in November the shaft was taken up and an extra keyway cut in the shaft and coupling. Two new keys were fitted, the loose shaft and coupling were bushed with sheet iron, and the keys were driven tight. A week of sawing was accomplished with this repair, but the next Saturday night found it loose again—a horrible job. The mill was kept going by five or six repetitions of this repair, spending from Saturday night until Monday morning each time. At last Jack Frost cut off the supply of logs and then there was an opportunity to make a permanent repair.

The coupling that made the trouble was on the second length of the main lineshaft, consequently it drove all the machines in the mill. The half coupling that was keyed on the first



The "Short" Coupling.

length of lineshaft or the countershaft of the engine remained tight and in good order. The couplings were of the hub and plate type held together by turned bolts. It was determined to replace the loose coupling by a new half coupling of the "Short" type. One was made of a length of hub sufficient to reach beyond the 9-inch section of the worn shafting onto 9 inches of unworn shafting, making a cast-iron cylinder about 18 inches long, with plate to match the good coupling on the countershaft. The coupling was cored out the first 9 inches of its length from the joint and the rest of its length was bored 8½ inches diameter, but eccentric with the periphery. A cast-iron bushing was turned to fit the bore and it was bored to fit the shaft, which was 7 inches diameter. It, however, was bored eccentric the same amount as the coupling was bored out of the center, so that when it was in place the coupling and the shaft would run true. This bushing was split apart by planing through the thick and thin sides. The opening on the thick side was made 1 inch wide, and ¾ inch wide at the thin side, but both of these spaces or keyways were ⅛ inch narrower at the inner edges of the bushing. Thus the bushing when cut apart made two half-circle wedges or keys about 1 inch thick at one side, or properly, end, and ½ inch thick at the other. Steel keys with gib heads were made to fit the opening sideways, the large key being made to tighten the bushing in place after being driven home, but the smaller key being made only to loosen the bushing. Holes for dowel pins 1½ inch diameter were drilled through the bushing and into the shaft at *A* and through the coupling and bushing at *B*, and dowels were turned and driven into these holes. Before bolting the couplings together the bushings and large steel key were slightly oiled and the key was driven hard home. It will be seen that because of the dowels the coupling and one half-bushing, and the shaft and the other half-bushing will tighten in opposite directions, the taper of the bushings and the drive of the setting-up key causing them to act practically like keys, and when wedged tightly in place the whole fitted together very much like a pressed fit.

This coupling drove all the machinery in the mill for about four years and was as tight when the mill was dismantled as when first put on. For ordinary line shafting, not too large, which rarely requires taking apart, the coupling may be a continuous sleeve without parting at the ends of the shafts. To show the power of the coupling to drive, the following experiment was made when it was first designed: A 1½-inch coupling as tightened onto two short pieces of shaft, one of which was secured to a heavy casting, and to the other was bolted a long beam. After twisting the shaft until it was simply a mass of disorganized fibers outside the coupling, the screws were loosened and the coupling was easily removed from its hold on the shafts. For very light shafting the bushing may be tightened by hollow setscrews with square holes for a wrench. The setscrews have conical points which fit into countersunk places in the bushings, but even in small couplings the key is best.

C. E. MINK.

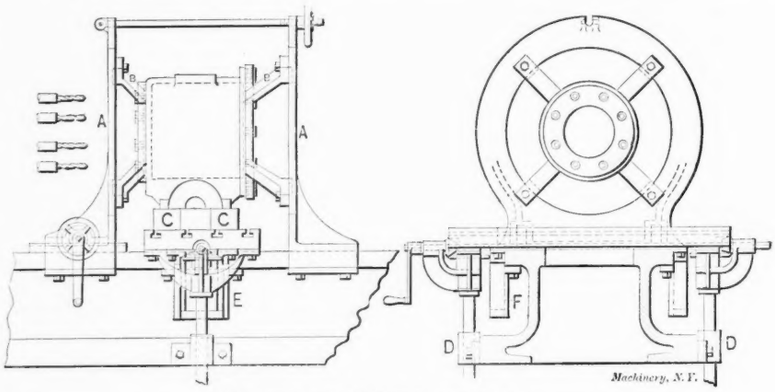
Syracuse, N. Y.

HOLDING THE WORK ON A HORIZONTAL MULTIPLE SPINDLE DRILL.

Editor MACHINERY:

The enclosed sketch of a double multiple drilling machine we think may be interesting to some of your readers who are interested in rapid drilling and good fixtures for the same.

The shop management having purchased a thirty-two-spindle horizontal drilling machine (sixteen spindles mounted in drill spindle head at each end of the bed, the drills pointing toward the center of the bed), principally for underwriter steam fire pump cylinders and centers, it became necessary to make provision for a work table, holders for drill jigs, etc., nothing of this sort having been provided for when the machine was ordered. We first designed and built the elevating table as shown in the cut, this being much the same as a horizontal boring machine elevating table, and elevated by means of right and left-hand square thread screws, one at each end of the table. A slide, *E*, of sufficient length to allow table to be elevated six inches is bolted to the under side of table at each end, just outside of bed of machine. The slide is a working fit in a three-sided guide, *F*, bolted to the under side of the overhang of the machine bed, and is plainly seen in the right-hand view. A strongly ribbed yoke connects the table and elevating screws, the elevating gears being between the yoke and the table. The pitch of the screws is two per inch, and the ratio of pinion and gears is four to one. The elevating



A Fixture for the Multiple Spindle Drill.

screw nuts, *D D*, are bolted to the base of the machine bed, as shown.

Two drill jig holders, *A A*, are mounted on machine bed, one on each side of the table, and are alike except that the right-hand one is placed in about the endwise position on the machine bed desired, and is clamped to the machine bed, while the one on the left hand is movable along the machine bed by means of a rack and pinion, the pinion shaft being squared at the end to receive a suitable crank. After the left-hand *A* has been brought up so that the drill jig is in position against the work, it is securely locked by means of the hand wheel shown in the left-hand view. *B B* are the drill jigs, and are, of course, made to suit the different castings or work (in this case being used with an 18-inch fire pump steam cylinder).

It will be noticed that the valve face of the steam cylinder rests upon parallels *C C* and, of course, much larger work can be accommodated when the parallels are removed. In setting a cylinder into the fixture, the proper height of table is

obtained when the left hand *A* is moved forward until the drill jig is against the cylinders, when a shoulder on the cylinder enters a recess in the drill jig; then the cylinder counterbore is forced upon a shoulder on the right-hand drill jig, centering each end perfectly. *A* and *A* are then firmly clamped together at the top by means of a swing bolt and hand wheel, and all is now ready to drill twenty or more holes at the same time. No attempt is made to show the drilling machine with the exception of a portion of the bed. The leading ends of the cylinder drills are shown as about to enter the drill jig bushings. Brackets *A A* are fitted and scraped to the machine bed, and are bored in place, and all drill jigs are finished with tongue to fit the bore of *A* and are bolted and doweled to it, as shown.

When the machine, fixture, etc., are set for a certain sized cylinder, the drilling can easily be done at the rate of twelve per hour. The one drawback to an otherwise good drilling machine is that the setting up of the machine consumes too much time when only a few pieces are to be finished, and "Jim" has often said he preferred to drill a single or a few pieces under an ordinary radial drill. A large enough number of pieces are seldom gotten together to make the machine as profitable as might be desired, and on this account it has been dubbed "The White Elephant." Of course other work besides pump cylinders is done in the machine when anything like a goodly number is gotten together. "B."

A HOLLOW MILL AND JIG.

Editor MACHINERY:

The faces *D*, *E*, *F* and *G* of the arm shown in Figs. 1 and 2 had been finished as a first operation, but on the other end of the arm is a boss on which the faces *A* and *B*, and the hole *C* had to be finished true in relation to faces *A*, *E*, *F* and *G* and at a certain distance therefrom. This last operation on these arms had always been done on the faceplate of an engine lathe, but a lathe of large swing, and therefore of heavy construction, was necessary and as the diameter of the boss had to come within a limit of 0.001 inch, the lathe was inconvenient and the time unsatisfactory. To obviate the necessity of swinging the piece in the lathe, the hollow mill shown in Figs. 6 and 7 and the jig shown in three views, Figs. 3, 4, and 5 were designed. With these appliances, the work was done in the drill-press with a reduction of 50 per cent in time over the old method. Moreover, not as highly skilled labor was required to do the work.

The jig for holding the arm includes the body *G* which carries the hardened bushing *H* for guiding the mill. At the opposite end and on the underside a boss was turned to fit the faces *E* and *F* on the arm. This boss was for locating the arm in the proper position, the arm being clamped by means of the bolt *I*, the split strap *J* and the nut *K*. The bolt *I* is prevented from turning by the headless screw *h*. The set-screw and check-nut *O* are used for locating the end of the arm sideways. The hook-bolt *L* and knurled nut *M* are used to resist the pressure of the mill when cutting.

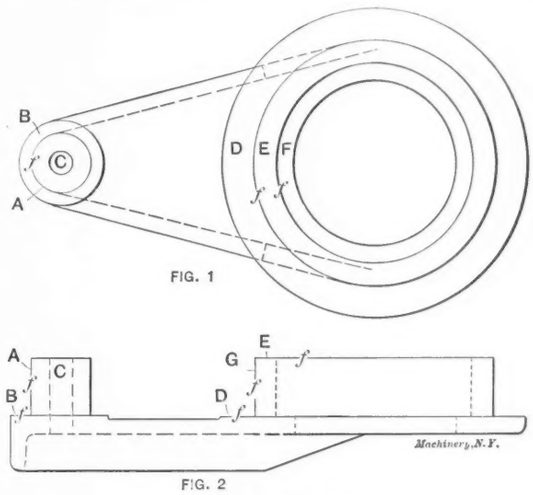


FIG. 1

FIG. 2

The Piece to be Milled.

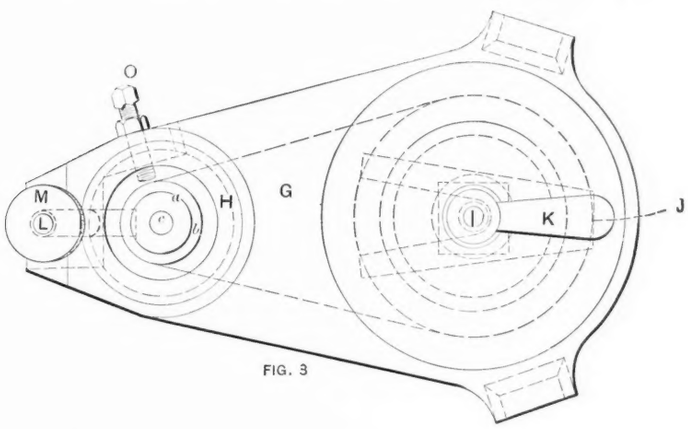


FIG. 3

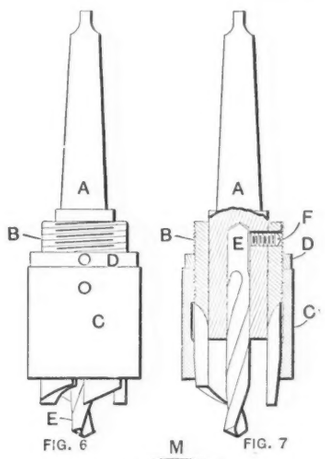


FIG. 6 FIG. 7

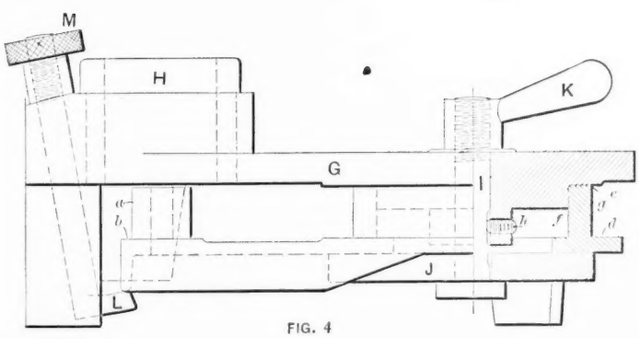


FIG. 4

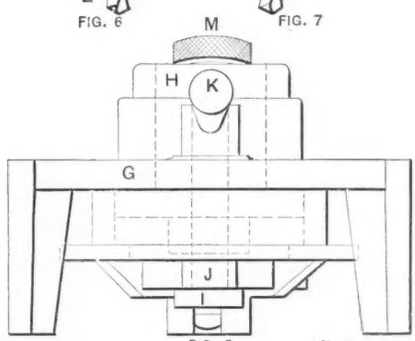


FIG. 5

Fixture and Tools for Hollow Milling.

The hollow mill is made up of the body and shank *A* onto which is driven the cutter or hollow mill *B*. The upper end of the cutter is externally threaded and the lower part is slightly tapered toward the end. The shell *C* is fitted over the cutter *B* and the upper part is internally threaded to fit the thread on the cutter. The lower end of the shell is bored to the same taper as the cutter so that when the shell is screwed upward it will partly close the cutter teeth inward, the same as a split clamp. The hole in the cutter is made slightly

larger than the shell to be milled, so that when the mill is closed to the right size it will give proper clearance on the inside to the cutting edges. The shell *C* is locked in position by check nut *D*, both check nut and shell being provided with holes for adjustment with a spanner. It is needless to say that the shell is hardened and ground true with the hole in the mill. For drilling the hole *C* in the end of the arm at the same operation, a common twist drill *E* is fitted in body *A* and held there by the headless screw *F*. CHARLES THIEL.

Lawrence, Mass.

BEAM COMPASS CONVERTED INTO A HATCHET PLANIMETER.

Editor MACHINERY:

In the September issue (Engineering Edition) you published an article on the hatchet planimeter. I had been using a borrowed one and as the results were very satisfactory I made up my mind to make one. But before I had time to secure the material for doing so, I happened to be using my beam compasses, which are made like the illustration Fig. 1, and the thought came to me, Why not try a hatchet end in it? This was very quickly made and soon tested.

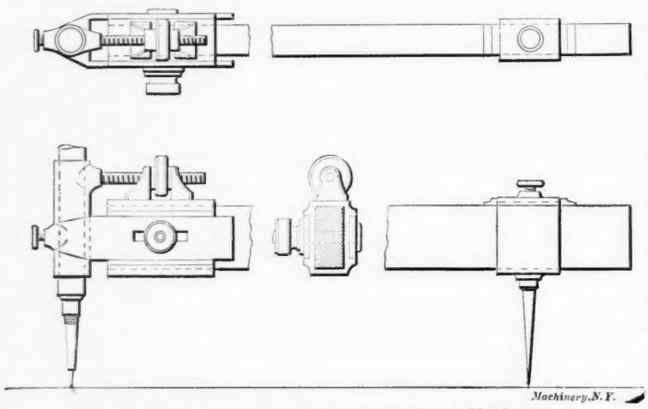


Fig. 1. A Beam Compass which was used as a Planimeter.

I find the areas given by this to be very close, and the way I used it, of course, hardly needs any explanation. The hatchet being inserted in the end where the pencil is shown in the drawing, and the point being set exactly 10 inches away. This is very easily done, as the rod from which the hatchet was made is exactly 5-16 inch diameter. So measuring from the edge 10 inches minus 5-32 inch gives exactly 10 inches

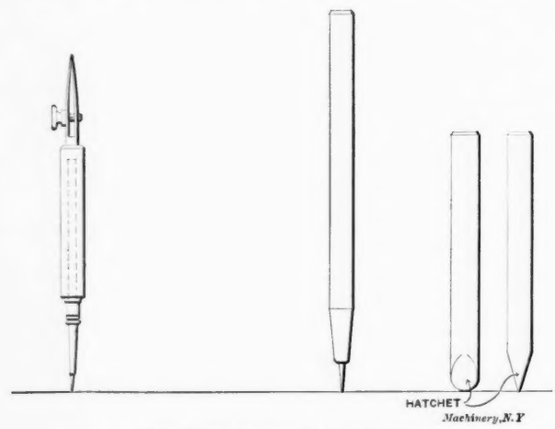


Fig. 2. The Compass Attachments.

between centers. In order to get the line of the hatchet edge true with the center I lay it down on a steel straightedge sideways, which lines up the edge, and then the binding screw shown in front is set up.

The beam compass is one that I made ten years ago; it was copied from one that was made for doing very accurate mill work, and the design allows the application of the hatchet very well. The long rod with the point is a very useful tool, also, for measuring, say, a radius on two levels, such as patterns sometimes have. The rod is let down on the point to be measured and then drawn up to be laid on the scale for reading the length; or, the reverse, the length may be taken first and then the rod let down to scratch the radius.

The drawing shows the trammels as made for an aluminum bar, but as I use mahogany bars of different lengths there is a gib and a setscrew on the under side to keep the head tight and prevent movement. ERNEST J. LEES.

Cleveland, O.

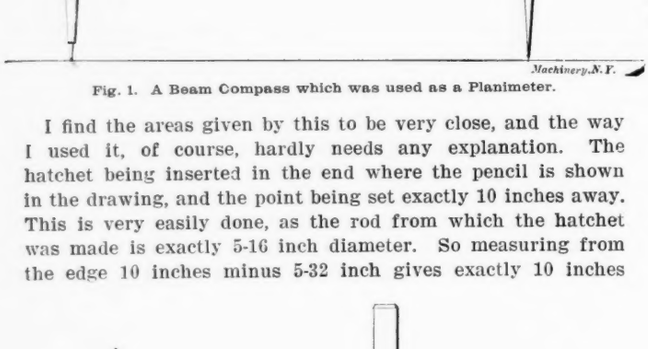
MAKING BLUEPRINTS FROM TYPEWRITTEN ORIGINALS.

Editor MACHINERY:

I had a lot of data and tables of standards of which I wanted blueprints, and as it would take a lot of time and be expensive to have a draftsman make them in the usual way, the idea occurred to me to try to do it on the typewriter, as it would be quicker, neater, and less expensive. I did considerable experimenting before I found the right combination to give the best results, but will give the results of my final experiments only. What is desired is a sharp, black copy that will make a good, clear blueprint, and the method of making these originals is as follows:

Upon a sheet of copy paper such as used for manifolding, lay a sheet of carbon paper face up; take a piece of tracing paper and lay it on the carbon paper and put them in the typewriter in this order so as to write on the tracing paper. This will give you a copy on the front and back of the paper that will be strong enough to take blueprints from if the following is closely observed.

A good black ribbon is required, a new one if possible, but do not use one that has been used for any length of time and that will not strike up a good sharp black letter; a good carbon paper is also required. I use a new sheet every time so as to get a good uniform letter; the carbon sheet can then be used on regular manifold work so that we lose nothing by it. The paper used for backing is the regular copying paper used for manifolding, but this is immaterial and can be made to



Reproduction of Typewritten Original. Obverse and Reverse Sides.

suit different machines. I have found that the best paper for the original is a good tough grade of thin tracing paper. I used Keuffel & Esser's "Series" brand, which takes the ink and carbon well and from which mistakes are easily erased without damaging the paper. I had some trouble to find a carbon paper that would give a good black uniform impression, but I finally obtained some of the "Pilot" brand from the United Carbon Company that suited this purpose exactly.

I am sending you samples of the paper that I used on this work and some of the blueprints that have been taken from some of the tables. The table of decimal equivalents, was taken from an original made on regular manifolding paper and as you will see is a little cloudy. The other print of wire gages was taken from an original made on "Series" paper as described above and as you can see is a good clear, sharp print. I have tried this method of making originals on tracing cloth with fair results, but it is not so easy to erase on as the tracing paper.

In making erasures use a soft rubber, as an ink eraser will rough up the surface of the paper, and when the character is struck over, it will smut. To correct mistakes, turn up the paper and place at the back some smooth object (say a piece of glass or a celluloid triangle) and erase on the face, then place it on the face and erase on the back; the desired character can then be struck in.

The lining can be done either before or after typewriting. The way that I do it is to put the sheet of paper in the machine and space off with the space bar and strike the dot, then space vertically with the carriage shift key and strike the dot, taking care to keep the dots outside of the margin of the finished sheet, then take the paper from the machine, rule the lines, put it back in the machine with the carbon paper as described above and fill in the numbers and characters as desired. Care must be taken to have a good uniform original if good prints are desired. I have tried this method on several makes of machines, but have got the best results on the Hammond, as it gives a perfectly uniform impression.

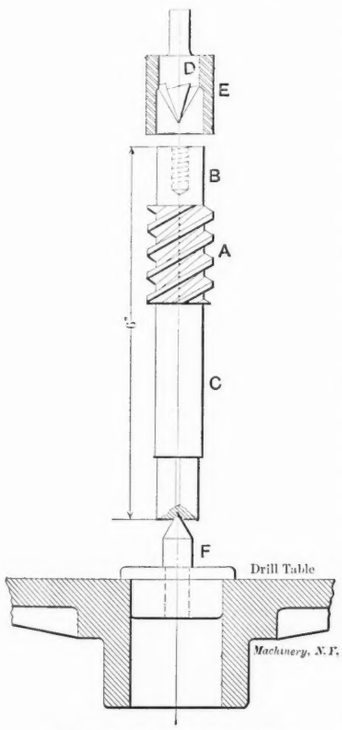
W. H. A.

[The blue print of wire gages is clear and plain, and that of the decimal equivalents is good enough for all practical purposes. Two photographic reproductions, slightly reduced, are shown herewith of a small typewritten original, front and back, and the fact that it reproduces in this manner clearly is a guarantee that it will blueprint well, provided the printing is done on transparent paper such as any good tracing paper or cloth.—EDITOR.]

DRILL-PRESS CENTERING DEVICE.

Editor MACHINERY:

Having a few hundred composition pieces to thread at *A*, we proceeded to run them on centers in the lathe, but found that the end, *B*, would not run true. It was necessary that the thread should be true with the parts *B* and *C*, which were already turned to a fit. The end, *C*, was centered true, but the end, *B*, was threaded internally, and not properly chamfered. Some pieces would run out as much as 1-32 to 1-16 inch, and we, therefore, had to find a way to get a true center in that end.



A Drill Press Centering Device.

Such obvious ways as using a steadyrest, universal chuck, etc., were considered, but they were all too slow to use on the quantity required. Finally, we hit upon the following: A piece of steel, *E*, was chucked and bored a tight fit for a standard four-fluted center reamer, *D*, and then counterbored a running fit for the end, *E*, of the composition piece, the outer corners being slightly rounded. This tool was then caught in the chuck of a small drill-press, and the lower center, *F* (which we use when centering shafts), was placed in the hole of the round table, directly under the tool. Then, by simply holding the piece with the hand, and just allowing the reamer to touch the hole, we were able to center the entire lot in about one hour, and with an accuracy to within 0.002 to 0.003 inch of truth, which was perfectly satisfactory. We were then enabled to thread the pieces without further trouble.

Newark, N. J. ELMER G. EBERHARDT.

SOLDERING.

Editor MACHINERY:

Soldering is usually considered a very simple job, but nevertheless it often gives the toolmaker or machinist considerable trouble unless he has had some previous experience. The following remarks may be an aid to some one who is "up against it."

Soldering "irons" are usually made of copper, as copper is easily heated and easily gives up its heat to the solder. The point of the iron must be "tinned." To do this properly, the iron should be heated hot enough to easily melt the solder; the point should then be quickly dressed with a smooth flat file to remove the oxide, and rubbed on a piece of tin through solder and sal ammoniac. The latter causes the solder to adhere in a thin, even coat to the point of the iron. A gas or gasoline blow torch, or a charcoal furnace is best for heating the iron, but a good, clean coal fire, well coked, will answer the purpose.

When in use, the iron should be kept hot enough to readily melt the solder. A cold iron produces rough work. This is where the beginner usually falls down. If possible, it is well to warm the pieces before applying the iron. The iron must not be heated too hot, however, or the tin on the point will be oxidized. The surfaces to be soldered must be clean. Polish them with sandpaper, emery cloth, a file, or a scraper. Grease or oil will prevent solder from sticking.

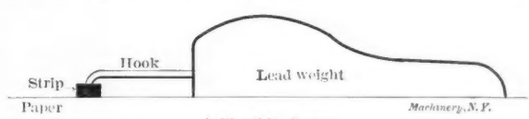
Some good soldering fluid should be used. A very good fluid is made by dissolving granulated zinc in muriatic acid. Dissolve as much zinc as possible in the acid. The gas given off will explode if ignited. To granulate the zinc, melt it in a ladle, and pour it slowly into a barrel of water. A brush or swab should be used to spread the fluid on the surfaces to be soldered. If the point of the soldering iron becomes dirty, it should be wiped on a cloth or piece of waste that has been dampened with the soldering fluid. O. L. LEWIS.

Indianapolis, Ind.

FLEXIBLE CURVES FOR DRAFTSMEN.

Editor MACHINERY:

You have occasionally had descriptions of flexible curves for draftsmen's use, but I do not remember to have seen any reference to the method employed by ship draftsmen for drawing curved lines. While most of your readers are familiar with the method, it may be new to some of the young fellows. As long ago as the sixties, when I was spoiling double-elephant paper in Chester, we used for ship-lines and other long non-circular curves flexible strips of wood about 3-16 inch wide and thick, which were held in position by "ducks' heads" of lead with bent-down iron points, somewhat as shown in the sketch. Several points in the curve being found by ordinates and each marked by a dot, one end of the strip was brought in the right place for commencing the line at one end, and



A Flexible Curve.

held there by the sharp downwardly-bent point of the steel hook, the strip brought to the next fixed point and similarly held, and so on to the end of the curve. Or, first, the middle was placed and then we worked toward both ends of the line alternately to right and left.

For holding small pieces of tracing-paper or cloth over the middle of a large drawing, when it was desired to trace only a small detail, and making holes in the drawing with drafting-tacks was not admissible, we held the transparent material in place with the same "ducks' heads," using small pieces of india rubber or of cork between the iron point and the tracing to make up for the height of the wooden strips with which the "ducks' heads" were normally used.

Hard rubber would be better than wood for the strips, if it were not for its property of soiling the drawings.

Hanover, Germany. ROBERT GRIMSHAW.

A DECEPTION THAT DID NOT WORK.

Editor MACHINERY:

Morgan, a young friend of mine, was, during his foreman's illness, filling the position, and was sent to inspect some special drilling machines ordered by his employers. In the specifications sent out by the firm a certain sized hole was required to be drilled out of the solid. Arriving at the toolmaker's, which was located some little distance away, he was received by the manager. After they had talked quite a while on things in general and machine tools in particular, he was conducted

to the machines. These were of the upright type. One machine was belted up for drilling, the others set up for testing as to the alignment, etc. Trammeling the tables from the spindle, Morgan found them within the limits stipulated, but the bases were all so very good he became a little suspicious. He had erected drilling machines himself. Casting around for anything which might affect the accuracy, his eye caught the wedges used to level up the machines. He kicked these away and gently pushed one under each corner with his fingers, just tight enough to take the weight. Then testing again, it was found to be not so good as before. The base had been, as he surmised, sprung into true by the wedges. He explained this to the manager, who was always hovering around, and there was a terrible row, the manager "jacking up" every one connected with the job. Going through the other machines (there were eight altogether) they found that two were sufficiently out of true to demand replaning. These he filed down at the corners as a guide to the planer and a check for himself. To Morgan's surprise, it was now nearly noontime. The manager took him out to lunch, but he insisted upon paying for himself, thinking it unwise to be under much obligation to them in case of future trouble. After lunch, the drilling test was to be gone through. From what he had seen of the machine, it looked short of power.

When they reached the machine, a cast-iron piece was clamped on the table and the operator was ready to drill it. To his surprise it took the cut all right, going right through the piece 3 inches thick at the speed stipulated. As he casually looked at the hole, the metal did not seem to have been annealed, a thing he had been warned against. While the test piece was being removed, he noticed a piece of wire about five-sixteenths diameter among the chips; it upset him considerably. He could have sworn it was not there when the cut was started, and it being there after suggested a fake. But what it was he could not think. While he was trammeling the machine which did the test, he was thinking, thinking very hard, how he could get around the deception which he felt sure was being practiced upon him. Not knowing what it was made it worse. Morgan made up his mind to have another piece drilled, an ordinary piece out of the shop if possible, but how to ask for it he did not know. Inspector's work was new to him, and he, at that time, couldn't bounce. Sending a helper for the manager, Morgan said he was sorry to give trouble, but his instructions were to have two machines tested for drilling, one of them picked out at random by him. The manager, after demurring a little, saying that they were all identical, and therefore what one could do they all would do, agreed to have another belted up, and suggested adjourning to his office while it was being made ready. Morgan went down, not because he wanted to—he wanted to watch them get it ready—but because he did not know how to refuse. However, after a while news came that the machine was ready, so they went up to it. A little thing Morgan thought was peculiar was that the position for the hole had been marked out and the center pricked. Why it should be so he did not know. The operator started the cut, which went all right. When the spindle had traveled about an inch Morgan stepped over and quickly stopped the feed and raised the spindle.

The deception was exposed; from the reverse side of the block a small hole had been drilled all but through, taking out the center of the hole. In the previous case they had evidently drilled the hole right through and plugged it with wire, an easy fit.

There is not much more to be told. Morgan cleared out as quickly as he could, made his report, and his firm refused the goods. They afterward, much to Morgan's disgust, bought the machines at a slightly lower figure. H. T. M.

JIM AND HIS DRAFTING ROOM.

Editor MACHINERY:

Jim came in to see me the other day. He was an apprentice boy under me eight or ten years ago, and before he had been in the shop six months I saw he was a good piece of stock and I pushed him for all he was worth. If you get hold of a good piece of material, whether it be steel or humanity, there is a pleasure in seeing the chips peel off and the finished product come out of the rough, and so it was with Jim. He was country, clean through, but he shook the hayseed out of his hair and did well.

He stayed out his three years as apprentice boy, and then he was put on the tool job. He seemed to have a natural aptitude for die work and knew just what a piece of metal would do, and what the tools should be to make it successful. He had left me to take a position in a large Western shop as foreman of the press and die work, and though I knew that he had made good and was well liked by the firm, I had never seen him since he left.

After talking over old times, and the whereabouts of the rest of the boys we used to know, I said: "Well, Jim, what is the worst thing you have run up against since you were here?" Jim thought a moment, then laughed and said: "Drafting, I guess, but I got over that all right, and I will tell you about it.

"You see, it was like this: I hired out to run the die and press job, and also do all the designing of the tools for the work, and though it gave me no more trouble than I expected, it kept me on the jump to get the sketches made so as to keep the die-makers working. I had done it for a year, and I knew that I stood 'ace high' with the firm, so I asked for a draftsman, and what do you suppose they said. That they had no draftsman they could spare out of the drafting room for die work, and also kind of carried the impression that dies didn't need to be drawn out on paper anyway. Well, I was mad clean through, but I kept on sawing wood.

"I had three or four bright young fellows, and one of them was going to night drawing school. I only had a 3 x 4-foot office, and I could not squeeze him in anywhere, and so I had to make other arrangements. The shop was very high in the walls, and over in one corner of the building there was a time office, through which the men used to come and drop their checks as they entered the works. This office was 20 x 20 feet and 8 feet high, with a good ceiling of matched boards. Well, I took and cleaned off the top and roof, and fitted up a long nice drafting table with a couple of electric lights, or rather I got two long extensions and ran them from the press lights up, so they would drop down over the drafting table. I also procured a roll of paper from the drafting room. Then I would sketch out the work in the office, call in the boy and explain to him what I wanted and have him draw it out to scale. He took to it as a duck takes to water, and soon would turn off a better job than I ever could. We had to use a ladder to get up there, and it was a pretty warm place, but otherwise it was O. K.

"It had been going along this way for several months, and one day the 'super' came in and saw the boy up there. 'What is that kid up there for?' said he. 'Oh, he is just making a sketch I didn't have room for down here,' I replied, and that was all there was said about it. I got the drafting done, the kid got a lot of good experience, and the company got the goods and paid for them, even if it didn't get in the bill. I do not know that it was just honest, but I don't care much—I had to do it, or I would have gone 'bug-house.' Did I do right?"

"Well, Jim, the company evidently got the value of their money, and there don't seem to have been any graft in it, so I think it was all right."

"There was one thing more I run up against, and though the methods I used were successful, I do not recommend them. One of the constructing engineers had a very haughty manner. He was an A1 man, but he used the rest of us foremen like dirt. One day he was passing through the room, and I said as he came by: 'Mr. Jones, I would like to see you a moment.' No reply. 'Mr. Jones!' Still no reply. 'Go to h——!' Jones wheeled around, and said: 'What was that you said?' 'Oh, you heard that time, did you? Well, never mind. Don't stop now, go right ahead; but I will find out, if I speak to one of my superiors in a respectful manner, whether I am to get a civil reply or not.' Jones came back and stayed an hour or more, and that was the last of my trouble in that direction." I am not advocating Jim's way of doing the jobs, but only tell of it to show what it is sometimes necessary to do in order to get there. A. P. PRESS.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

TO MAKE A BELT PULL.

Some time you may have a hurry-up job on a machine—perhaps you may never have had one—but should it fall to your lot to find that your belt will not pull the cut you desire, just find a piece of tar soap and hold it on the inside of the belt while it is running, and the result will surprise you and will materially aid you to finish the job on time.

Rochester, N. Y. CARROLL ASHLEY.

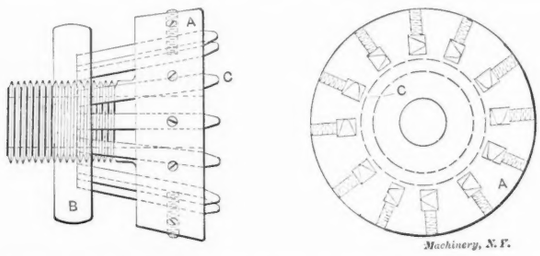
TO REMOVE BROKEN TAPS.

To remove a broken tap from cast iron the hole should first be thoroughly cleaned out by means of a small squirt gun filled with kerosene. All small broken pieces of the tap can be removed with a pair of tweezers. Then the tweezers, which should be as large as possible, should be inserted between the hole and the flutes of the tap and by slowly working back and forth and occasionally blowing out with kerosene, the broken piece is easily released. A through hole, of course, simplifies matters somewhat H. J. BACHMANN.

New York.

AN INSERTED TOOTH CUTTER.

Having noticed many styles of inserted tooth cutters illustrated from time to time I here submit a sketch of one of which the cost of making is not very great. The head, *A*, has holes into which the cutters are inserted, these to vary in size or number to suit the work; the cutters are held in the head by headless setscrews. The head has a taper hole running



clear through, into which an arbor is to be driven. The collar or adjusting nut, *B*, is grooved to allow the end of the cutters to enter. Having made several of this type of cutter and found them satisfactory, I submit same hoping it may be of some use to others. G. E. WHITE.

Ridgway, Pa.

TO HARDEN A HAMMER.

To avoid the danger of "checking" a hammer at the eye, heat the hammer to a good uniform hardening heat and then dip the small end almost up to the eye, and cool quickly as possible by moving about in the hardening bath; then dip the large end. To successfully harden a hammer by this method you must work quickly and cool the end dipped first enough to harden before you lose the heat on the other end. Draw the temper from the heat left about the eye. The result is a hammer hard only where it *should* be and free from "checks."

I. W. ANTANO.

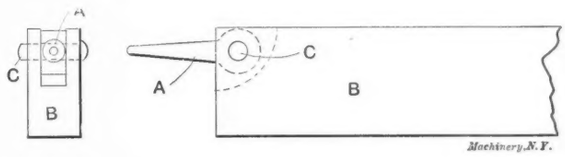
TO MEASURE A STANDARD V-THREAD WITH A MICROMETER.

A U. S. standard or Sellers thread may be accurately measured with a micrometer by the aid of three wires, preferably Stubbs steel. Select a diameter of wire that will lie in the thread nicely and project above the tops of the thread. Use two wires on one side in adjacent V's and one wire on the opposite side, so as to be in the middle plane between them. For convenience these wires may be sharpened and stuck into a block of soft wood, two on one side of the screw and one on the other. Then, having gotten the diameter as measured over the top of the wires, the thread diameter may be obtained by the following rule: From the diameter as measured over the wires, subtract three times the diameter of the wires. To the remainder add the quotient obtained by dividing 1.5155 by the pitch. For example, suppose that a 14-pitch screw is measured in this manner, using wire having a diameter of 0.053 inch, and the diameter over the wires is found to be 0.5507 inch. Subtracting 3×0.053, or 0.159 from 0.5507, leaves 0.3917. To the remainder add $\frac{1.5155}{14} = 0.1082$, giving the diameter as 0.4999, or ½ inch. ERNEST KROFF.

Cincinnati, O.

TO LINE UP LATHE CENTERS.

To line up lathe centers I use the simple and inexpensive tool shown in the cut. The stock is made of a short piece of bar iron of the same size section as the tool steel used for my lathe tools. The stock, *B*, is milled out as shown by the dotted lines in the side view to receive the pointer, *A*, which is held in position by the cross pin, *C*. The pin should be a close fit in the pointer so that while it can move freely there will be no shake. To use the tool turn a short space on the end of the piece which is to be turned straight, being careful to turn it perfectly round. Now, put the little indicator in

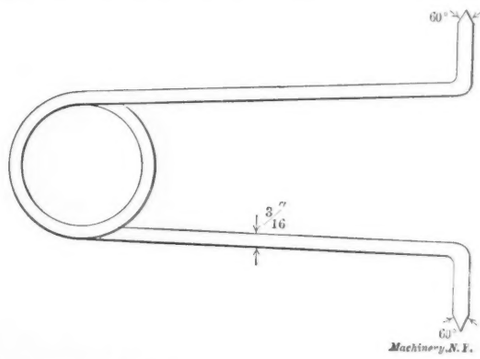


the tool post, and with the turned part next to the face plate, adjust the cross slide so that as the pointer is wiggled up and down, the work can just be felt. Reverse the work on the lathe centers and throw the pointer up out of the way and, without moving the cross slide, run the carriage along so the pointer may again be tried on the turned part of the piece. By adjusting the set-over screws until the pointer can be just felt against the work, the tail-stock will be set so that the lathe will turn straight. The tool is also very handy for many other purposes which will continually suggest themselves, and may be used advantageously on the planer.

I. W. ANTANO.

THREAD CLEANER FOR CHUCKS AND FACEPLATES.

The practice of cleaning out the threads on chuck and other faceplates every time they are screwed on the spindle is very necessary to maintain the accuracy of the chuck and should therefore not be neglected, especially by apprentices. The only instrument necessary is a piece of 3-16-inch drill rod bent into the shape of a safety pin and having its two ends bent outward with the points filed to 60 degrees, as shown in cut. Inserting this little tool between the threads and moving



around by hand insures the removal of all dirt and chips that have accumulated therein. In this connection it is also well to remember that after removing a chuck or faceplate from the spindle it should be laid away face down or with the chuck jaws resting on bench or floor, thus keeping the chips away from the thread as much as possible.

New York. H. J. BACHMANN.

[Filling the thread bore with waste or a plug of wood is a practice largely followed by careful machinists.—EDITOR.]

SHOP RECEIPTS AND FORMULAS.

This page will be used for the publication of shop receipts which the contributors know from experience to be practicable. Nearly all readers of MACHINERY can add something, and it is desired that they use this page as a medium for exchanging useful formulas, thus putting them on record for the general benefit of the craft. All published receipts are paid for.

123. SHELLAC CEMENT.

Shellac is the basis of most adhesive cements. A good one is made by thickening shellac varnish (shellac dissolved in alcohol) with dry white lead, mixing the two with a putty knife on a piece of glass. W. H. SARGENT.

St. Johnsbury, Vt.

124. PACKING FOR GASOLINE PUMPS.

For packing pumps on gasoline engines use asbestos wick-packing rubbed full of regular laundry soap; it will work without undue friction and will pack tightly. Common rubber-packing is not as good, as the gasoline cuts it out. A. A.

125. TO DELAY THE SETTING OF PLASTER-OF-PARIS.

Citric acid will delay the setting of plaster-of-paris for several hours. One ounce of acid, at a cost of about five cents, will be sufficient to delay the setting of one hundred pounds of plaster-of-paris for two or three hours. Dissolve the acid in the water before mixing the plaster.

Indianapolis, Ind. OTTO L. LEWIS.

126. TO REMOVE BURNT OIL FROM HARDENED STEEL.

To remove excess oil from parts that have been hardened in oil, place the articles in a small tank of gasoline, which, when exposed to the air, will dry off immediately, allowing the part to be polished and tempered without the confusing and unsightly marks of burnt oil. H. J. BACHMANN.

New York.

127. SUBSTITUTE FOR CEMENT ON GRINDER DISKS.

A good substitute in place of glue or various kinds of cement for fastening emery cloth to the disks of grinders of the Gardner type is to heat or warm the disk and apply a thin coating of beeswax; then put the emery cloth in place and allow to set or cool under pressure. G. HUBER.

Kansas City, Mo.

128. MENDING CEMENTS FOR CELLULOID.

To mend broken triangles and other celluloid articles use 3 parts alcohol and 4 parts ether mixed together and applied to the fracture with a brush until the edges become warm. The edges are then stuck together and left to dry for at least twenty-four hours.

Camphor, 1 part; alcohol, 4 parts. Dissolve and add equal quantity (by weight) of shellac to this solution.

New Britain, Conn. F. L. ENGEL.

129. LUBRICANT FOR HIGHSPEED BEARINGS.

To prevent heating and sticking of bearings on heavy machine tools due to running continuously at high speeds, fill an oil can with a good spring bottom (the "Gem" oiler preferred) about one-eighth full of Dixon's flake graphite, and the remainder with kerosene oil. As soon as the bearing shows the slightest indication of heating or sticking, this mixture should be forcibly squirted through the oil hole until it flows out between the shaft and bearing, when a small quantity of thin machine oil may be applied. H. J. BACHMANN.

New York.

130. TEMPERING COMPOUND FOR STEEL.

The following receipt for a tempering compound I have found very useful when it was impossible to procure a good grade of steel. This compound will be found specially good for cold chisels, center punches, lathe, flat drills, etc., and in fact almost any tool not having irregular forms or thin cutting edges. To 6 quarts of good clear rain water add 1 ounce of corrosive sublimate and 2 pints common salt. Stir until thoroughly dissolved. This compound seems to both harden and toughen steel; the tools are dipped and drawn in the usual manner. HERRMANN G. KROEGER.

Louisville, Ky.

131. RED WRITING FLUID FOR BLUEPRINTS

In answer to the request of D. C. T. in the December issue for writing fluids for blueprints, I would recommend him to take a piece of common washing soda the size of an ordinary bean and dissolve it in four tablespoonfuls of ordinary red-writing ink, to make a red fluid. The only way I know of to keep it from spreading too much is to use a fine pen to apply it with, and write fast so as not to allow too much of the fluid to get on the paper, for it will continue eating until it is dry.

H. E. W.

132. COLORED INKS FOR BLUEPRINTS.

Replying to the inquiry by D. C. T. in the December issue for red and white solutions for writing on blueprints, dissolve a crystal of oxalate of potash about the size of a pea in an ink bottle full of water. This will give white lines on blueprints; other potash solutions are yellowish. If this shows a tendency to run, owing to too great strength, add more water and thicken slightly with mucilage. Mix this with red or any other colored ink about half and half and writing may be done on the blueprints in colors corresponding to the inks used. W. H. SARGENT.

St. Johnsbury, Vt.

133. ANTI-FRICTION METAL.

An anti-friction metal of most excellent quality and one that I have used with success for a bearing on an internal grinding shaft, which was 5-16 inch diameter, 7 inches long, and 5 inches in the bearing, and run at a speed of 36,000 R. P. M. is made as follows: 17 parts zinc; 1 part copper; 1½ part antimony; prepared in the following way: Melt the copper in a small crucible, then add the antimony and lastly the zinc, care being taken not to burn the zinc. Burning can be prevented by allowing the copper and antimony to cool slightly before adding the zinc. This metal is preferably cast into the shape desired and is not used as a lining metal because it requires too great a heat to pour. It machines nicely and takes a fine polish on bearing surfaces. It has the appearance of aluminum when finished. Use a lubricating oil made from any good grade of machine oil to which 3 parts of kerosene have been added. HERRMANN G. KROEGER.

Louisville, Ky.

134. FOR ETCHING ON HARDENED STEEL.

First heat an iron or an old pillar file with a smooth side, and with it spread a thin, even coat of beeswax over the brightened surface to be etched. With a sharp lead pencil (which is very much preferable to a scriber) write or mark as wanted through the wax so as to be sure to strike the steel surface. Then daub on with a stick some etching acid made as follows: 3 parts nitric acid; 1 part muriatic acid. If a lead pencil has been used the acid will begin to bubble immediately. Two or three minutes of the bubbling or foaming will be sufficient for marking, then soak up the acid with a small piece of blotting paper and remove the beeswax with a piece of waste wet with benzine, and if the piece be small enough dip it into a saturated solution of sal soda, or if the piece be large swab over it with a piece of waste. This neutralizes the remaining acid and prevents rusting, which oil will not do.

If it is desired to coat the piece with beeswax without heating it, dissolve pure beeswax in benzine until of the consistency of thick cream and pour on to the steel and even spread it by rocking or blowing, and lay aside for it to harden; then use the lead pencil, etc., as before. This method will take longer. Keep work from near the fire or an open flame.

A. S. GUN.

* * *

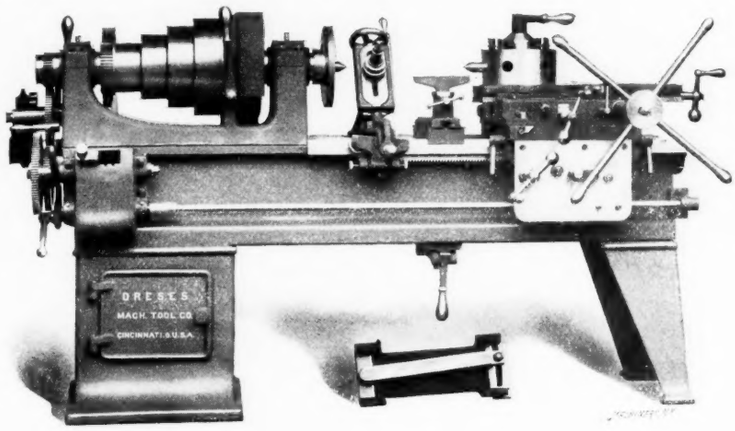
A waste product is something that is thrown away as having no economic value, but there is little that is absolute waste, even the chips produced in the machine shop being worked over into new iron and steel. There is one modern machining process that produces a shaving that has more value than that of mere scrap, and that is drilling rifle barrels with the oil-tube drill. The cutting edge of this drill is broken up into steps and the chips produced are literally shavings, being long hair-like threads of steel. These shavings are considerably used in woodworking factories for smoothing purposes.

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

DRESES UNIVERSAL MONITOR LATHE.

This machine is designed for general brass and other similar work of special and heavy character, with the idea of doing away so far as is possible with the costly special tools necessary in the ordinary monitor lathe. The carriage on which the turret is mounted has a feed similar to that on the ordinary engine lathe, which is independent of the feed of the tur-



The Dreses Universal Monitor Lathe.

ret slide itself. This feed is through a pinion and the usual rack, fastened to the under side of the flange at the top of the bed. Since this rack is cut to an even circumferential pitch it may be used in combination with change gearing at the end of the headstock to lead taps and dies for cutting pipe threads, etc. The four feeds obtained by this means are increased to twelve by the interposition of change gears; the reverse is made by a knob in the front of the apron.

The turret slide does not bear directly on the carriage, but instead is mounted on a secondary dovetailed plate which may be connected to the taper attachment shown on the floor below the bed. The frame of this taper attachment slides between the V's, and the bolt which clamps the guiding bar also serves to hold it in any desired position longitudinally. This attachment may be removed instantly when it is not in use. The turret slide bed may be fed across the dove-tailed plate by crankhandle shown in the cut if a hand cross feed is desired. Screw clamping stops are provided for setting the turret holes exactly in line with the spindle. The combination of positive lead through change gears, and taper turning by means of the taper attachment and dove-tailed slide, makes it possible to cut internal and external pipe threads of any diameter without the use of taps and dies. The turret carriage is provided with pilot wheel and screw feeds. The turret revolves on a stem which is adjustable for wear and the locking pin withdraws at the return movement of the top slide, thus making the action semi-automatic. The machine is provided with a chasing attachment of which the follower is made yielding for taper work. Right and left-hand threads may be cut without changing the leader. The head stock is friction back-geared and has a four-step cone, provided with ample belt contact. The spindle has a 1 13/16 inch hole and is arranged to be used with a wire-feed attachment if desired. The cabinet support under the head is provided with tool shelves and the tail-end leg is attached by a pivot to form a three-point support. The complete machine weighs about 2,900 pounds and is built by the Dreses Machine Tool Co., Cincinnati, Ohio.

NEW BICKFORD RADIAL DRILL.

This machine is the latest product of the Bickford Drill & Tool Co., of Cincinnati, Ohio. Its capacity for drilling from the solid is rated at 2 inches diameter for steel and 2½ inches diameter for cast iron. It is of new design throughout and contains a number of modifications over its predecessors, but its chief characteristic is the arrangement of the speed box which, without back gears or a clutch of any kind, give instantly with a single lever six changes of speed.

Referring to Fig. 2, which shows the arrangement of the driving gears, *C* is driven at constant speed by a belt as shown in the cut or by a direct-connected motor if so desired. On *O* is made fast pinion *D* which, through the intermediate *F*, drives the large gear, *M*. This gear revolves loosely on the shaft *L*, but is connected by a ratchet with a collar on this shaft, so that if there is no other connection, shaft *L* will be driven from shaft *C* through these gears. As shown in the cut, there is besides, however, a sliding pinion, *B*, keyed to shaft *C* which, with the intermediate *E*, may be shifted along to engage with any one of the five gears *G*, *H*, *I*, *J*, and *K*. Referring to Fig. 1, which shows a front view of the machine, when the handle is in the extreme right-hand notch of the speed box, gear *E* will be between *K* and *M*. As soon as

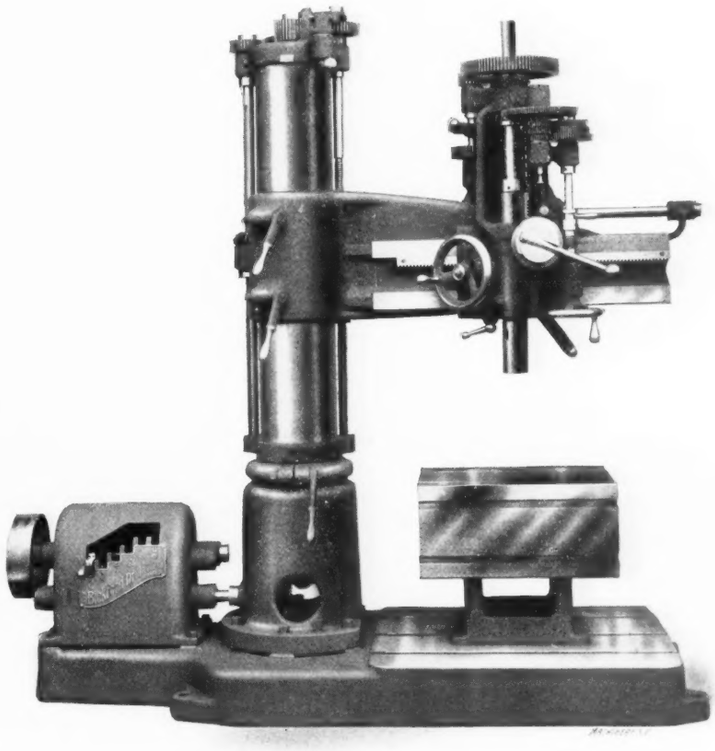


Fig. 1. The Bickford 2 1-2 and 3 foot Radial Drill.

shaft *L* is thus disconnected it will be driven from shaft *C* through *D*, *F* and *M*. If, however, the handle be moved one notch to the left, the drive will be through *B*, *E* and *K*, thus revolving shaft *L* at a greater rate of speed than gear *M*, a condition freely allowed by the ratchet connection between them. In

the same way the handle may be given any one of the four remaining positions, making possible six changes of speed in the feed box. The purpose of using a ratchet drive for the slowest speed is to allow gear *E* to be thrown into mesh with any one of its five mating gears while the machine is running. As the minimum peripheral speed of the smallest driven gear, *G*, is only 182 feet less than the peripheral speed of driving gear *B*, the shock which usually accompanies engaging gears broadside is reduced to a minimum, such shock as there is being absorbed by the belt.

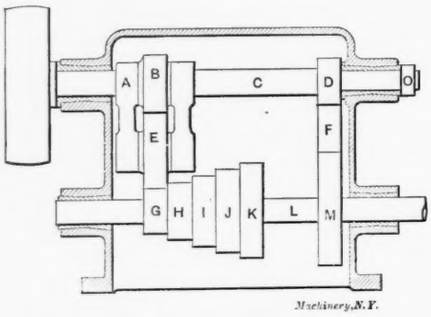


Fig. 2. Arrangement of Gearing in Speed Box.

A plate in front of the gear box shows the position the lever should take to give the proper speed for the diameter of drill which is in use at the time. The upper row of figures relates to the direct drive and the lower row to the back-gear drive, the back gears being located on the spindle head. The range of the twelve changes of speed thus possible is shown in the following table:

No. of Revs. per min. made by Spindle.	Diam. of Drills for which Speeds are Suitable.	No. of feet per min. at which Drilling is done.	No. of feet per min. at which Drilling should be done.
265.09	1/2	34.60	35.0
209.86	5/8	34.34	34.3
173.68	3/4	34.10	33.6
143.91	7/8	33.07	32.9
122.84	1	32.16	32.2
104.29	1 1/8	30.72	31.5
95.41	1 1/4	31.22	30.8
75.53	1 1/2	29.66	29.4
62.51	1 3/4	28.74	28.0
51.79	2	27.12	26.6
44.21	2 1/4	26.04	25.2
37.56	2 1/2	24.56	23.8

A comparison of the figures in the third and fourth columns indicates that the makers have been careful in the selection of gears, as in no instance does the cutting speed vary from the theoretically correct condition by more than 0.84 of a foot per minute. Another noticeable point is the irregular gradation of the speeds. The usual geometric progression is purposely departed from in this machine and instead, the various sizes of drills, as shown by the plate on the speed box, are each given their proper surface speed irrespective of the relation which these different speeds bear to each other. The makers claim that this gives practically a more useful range than does the true geometric progression which will give rates of speed varying from 2 to 9 per cent greater or smaller than they should be for the commonly used diameters. The machine is also furnished with a five-step cone drive, a constant or variable-speed motor drive, a swinging or swiveling table, and a round or double end base.

THIRTY-SIX SPINDLE AUTOMATIC DRILL.

The half-tone shows a multiple-spindle drill built by the Moline Tool Co., Moline, Ill. The work table is an annular ring which may be indexed to ten different positions and is intended to carry, clamped to it, ten work-holding jigs. The drill head is spaced to carry ten separate groups of drill spindles, four spindles in each, but one of the groups is omitted so as to allow a position in front of the operator where the work can be removed and inserted. This gives a total of thirty-six spindles to the machine. Each separate drill is vertically adjustable to allow for different lengths of drill and heights of work, and the table is vertically adjustable in addition to the movement given by the feed mechanism. The feed is operated by the cam shown in the base, the table and work-carrying ring moving up toward the drill spindles, as the feeding progresses. The feed and the indexing and locking of the ring are all automatic, so the workman has nothing to do but keep the machine supplied with work. A rotary oil pump and tank for lubricant is provided.

A Multiple-spindle Automatic Drill.

DIRECT-CONNECTED ENGINE AND FAN FOR HANDLING HOT GASES.

In designing fans for induced draft plants for boilers there is considerable difficulty in supporting the shaft in such a way that it shall be rigid and at the same time have its journals located where the heat of the furnace gases will not affect the bearings. It is impossible to support the shaft by outboard bearings at the inlet side of the housing on account of the fact that this would be in the direct path of the hot gas.

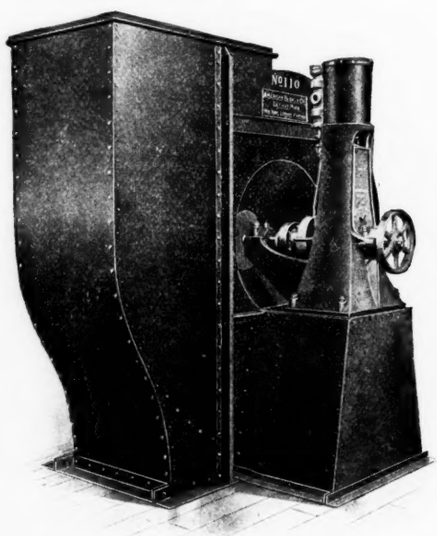


Fig. 1. Improved Arrangement of Engine and Fan Housing.

The American Blower Co., of Detroit, Mich., is using a construction which obviates the difficulty and makes a very satisfactory construction in other respects as well. Fig. 1 shows a fan directly connected to a vertical high-speed engine. The shaft is supported by bearings, three in number, in the engine frame, all of them made in one casting and bored out at the same time. This means that they are permanently in alignment and do not require to be journaled in self-adjusting boxes. The blades of the fan itself, instead of being supported by a double or triple spider as is usually the case in units as large as this one, are mounted on a single central spider whose arms, made of rolled steel, are cast into the iron hub. The

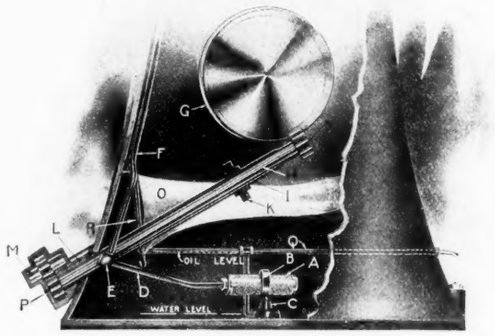


Fig. 2. Oiling Device for Engine.

blades are braced to each other and to the arms in such a way as to make an exceedingly rigid construction. This use of a single central spider allows the outboard bearing of the engine to be placed much nearer the center line of the fan than would otherwise be the case. As may be seen in the half-tone, the fan housing is recessed to allow this to be done. Another advantage of making the three bearings in the engine frame instead of mounting the third one on the housing as is sometimes done, is that all strain is thus removed from the sheet metal casing, which may thus be of considerable lighter construction than would otherwise be necessary.

The engine is of the enclosed type with all of the bearings oiled by the positively driven pump shown in Fig. 2. *G* is a worm of large diameter mounted on the crankshaft and driving the small worm wheel, *N*, which in turn drives the two gears *P* and *M* of a rotary geared pump. This pump gets its supply of oil from a reservoir in the base and forces it through pipe *F* to the various journals, bearings, etc., even lubricating the eccentric outside of the frame. Tests in actual practice have proven that it will run several months without oiling or adjustment.

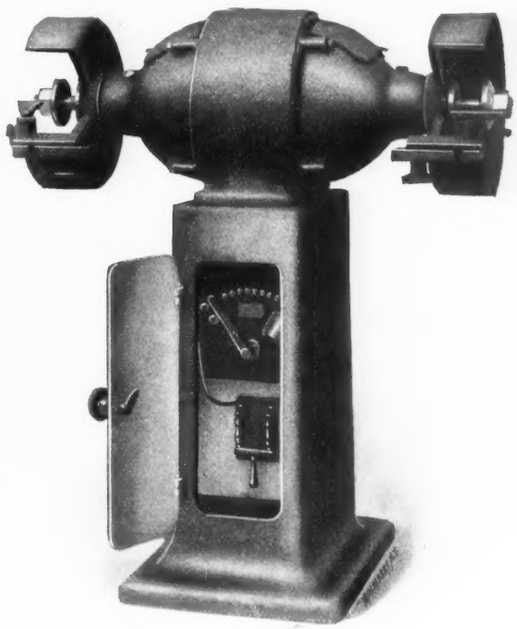
FAY & SCOTT THIRTY-EIGHT INCH ENGINE LATHE.

This new machine has recently been added to the line of lathes built by Fay & Scott, of Dexter, Maine. The spindle is driven by triple gearing and is made of high-carbon steel with accurately ground journals. The bearings are made of bronze, scraped and fitted. The carriage slides on longitudinal V ways, carries a compound rest, an auxiliary wing rest, and is securely gibbed to the bed. The apron is tongued and grooved into the carriage, and all gears and studs are particularly heavy. The tailstock is of the cut-away type.

The ratio of the back gearing is 12 to 1 and of the triple gearing 40 to 1. There are five steps to the cone, varying from 8 to 22 inches in diameter for a 4-inch belt. The hole through the spindle is 3 1/16 inches in diameter. The front journal is 6¼ inches in diameter by 10½ inches long, and the back one is 4½ inches diameter by 7 inches long. The machine swings 24 inches over the carriage and weighs 14,500 pounds with a ten-foot bed.

THE RANSOM MOTOR-DRIVEN DRY GRINDER.

This machine is one of a line built by the Ransom Manufacturing Co., Oshkosh, Wis. It will take a wheel 12 inches in diameter by 2 inches wide. The line includes four sizes, of which the largest will take a 30-inch wheel 4 inches wide. The emery wheels are mounted on the extended armature shaft which is made of high carbon steel of large diameter, turned and ground. The journals are ring oiling and run in dust-



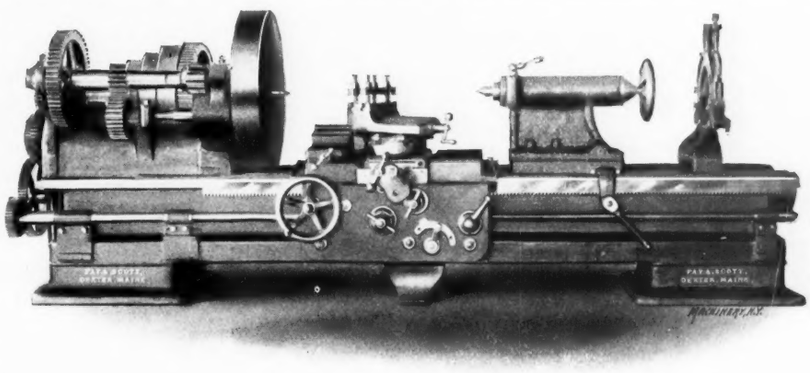
Ransom Motor-driven Grinder.

proof phosphor bronze boxes. In the arrangement shown in the cut, the machine is mounted on a heavy sub-base with floor area large enough to insure steady running. In the cupboard in this base are mounted a starting box, switch, and non-arcing fuses. The grinding rests are supported by heavy cast-iron shields which encircle the wheels, leaving open only the space where the grinding is done. The machine runs at 1,700 revolutions per minute.

THE STOW ELECTRIC EMERY GRINDER.

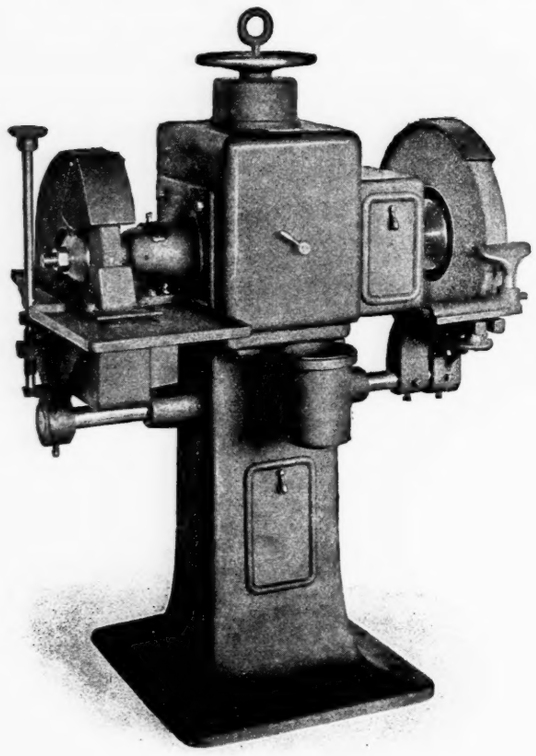
This machine, as shown in the accompanying half-tone, is a combination wet and dry grinder driven by the well-known Stow variable-speed motor. The wet wheel mounted on the left side of the motor is properly encased and the water tank below the wheel may be elevated to any desired height by a turn of the vertical rod shown on the extreme left. The level of the water is then raised into contact with the wheel and a more even distribution is possible than with the older foot-pedal arrangement. Both wheels are provided with convenient adjustable grinding rests. A cast-iron water pot is located between the wheels.

The use of the Stow type of motor allows the operator to



Fay & Scott Thirty-eight inch Lathe.

obtain exactly the speed required for his work to give the best results. The change is made by infinitely small gradations and not, as is the case when a rheostat is used, by comparatively long steps. The motor is started and stopped by turning the short lever on the front of the frame to the right or left. Speed variation is secured by turning the hand wheel



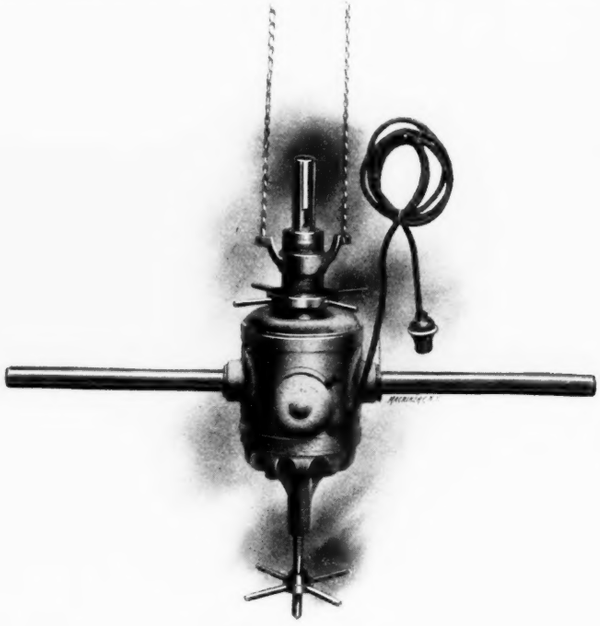
Variable Speed Motor-driven Grinder.

on top of the motor. The base is large and the running parts carefully balanced to reduce the vibration as much as possible. The machine shown is adapted for wheels not exceeding 2 x 18 inches in diameter. The Stow Manufacturing Co., Binghamton, N. Y., are the builders.

TWO NEW ELECTRICALLY-DRIVEN TOOLS.

The electric drill and grinder shown herewith are examples of a line manufactured by the United States Electric Tool Co., of Cincinnati, Ohio. These tools may be carried by a workman from place to place wherever his work takes him, and on being attached to a lamp socket, they will serve to drill or grind anything within the limits of the tool's capacity; for the drill, this capacity ranges from ¼ inch up to and including 1¾ inch in diameter, depending on the size. The tool illustrated has power enough to handle a 1¼-inch drill. It is 22 inches high, 7½ inches wide, and each handle is 14 inches long. The tool is provided with screw and chain feed. In case the latter arrangement is used, a chain is passed around the work and its two ends fastened to the yoke which is mounted on the spindle sleeve. The feed is obtained by a threaded nut, which draws the whole mechanism forward through the yoke. A common drawback in using electrically-driven drills is that when the point of the drill is about to break through the hole it is liable to fracture, due to the increase of speed and irregularity of the cut. This bad feature is overcome by the builders of this line by equipping each of the different sizes with a variable-speed control which gives four different rates of speed to the spindle; when the drill is on the verge of breaking through the material, the speed may be lowered instantly, thus saving the tool. This arrangement also provides for working with different diameters in different materials.

The grinder shown should find extensive use throughout the machine shop. It can be applied easily to a lathe, milling machine or planer, it can be run independently on the bench, or it may be used as a portable tool for cleaning castings in the foundry or shop. A feature of both the drill and grinder motors is that they are built up of thin layers of steel, both in the case of the armature and the field, thus making the motor more efficient and powerful than if they were made of cast or



Electrically-driven Drill.

wrought iron. These electrically-driven tools serve as well for a number of miscellaneous uses, such as, for instance, drilling and tapping staybolt holes in boiler shops; one of the latest developments is their use as flue expanders, when provided with suitable attachments.

THREE-HOLE CLEVELAND AUTOMATIC SCREW MACHINE

This machine resembles in its design and appearance the regular line of automatic turret machines made by its builders, the Cleveland Automatic Machine Co., Cleveland, O. It is designed for making parts from bar or magazine which can not be handled on the plain machine, and which do not require enough operations to make the use of the regular turret machine advisable The turret, which is made to hold three tools, has holes 1½ inch in diameter. On the regular 1¼-inch turret machine they are only 1¼ inch in diameter and this enlargement allows the use of large hollow shanks

Portable Electrically-driven Grinder.

for the milling tools, die holders, etc., thus making it possible to take longer cuts of larger diameter than can be handled by the regular line of machines.

The machine consists essentially of a spindle driven by a shifting belt to allow reversal for thread cutting, and provided with means for feeding and holding a bar of stock; a longitudinally placed drum turret provided with mechanism for indexing and locking it; and a cam shaft at the rear of the machine which governs all its functions and may be given a

slow motion for feeding or a rapid motion for the idle movements. The spindle mechanism is similar to that on the regular Cleveland automatic screw machine. The belt is shifted for reversal by a quick-acting mechanism governed by dogs on the cam shaft. Other cams on the same shaft open and close the chuck and feed the stock. The feed cam is longitudinally adjustable to vary the length of stock presented to the action of the tools. The head stock, when necessary, may be provided with the three-speed attachment which is furnished with the regular machine. The cam shaft at the rear of the machine is driven by a belt from the countershaft through pulleys *G* or *D*, the change gears, and a worm and worm wheel. A series of dogs, *C*, is adjustably clamped around the periphery of the worm wheel, in position to engage the free end of a belt-shifting lever. Inside of pulleys *G* and *D* is situated a differential gear train which gives either a rapid or a slow movement to the mechanism, depending on which pulley the belt is driving. By suitably disposing the dogs, *C*, the cam shaft may then be given a fast or slow motion at predetermined points to suit the work that it has to do.

The cross slide is governed by cams in the same way as on the regular machine and will take the same tool post, tools and magazine attachments that the regular machine does. It is regularly built to use a single tool, but can be made to use a front and back tool if desired.

The mechanism for rotating and locking the turret is new with this machine. Around the inner edges of the drum *H* are adjustably clamped dogs, *A*, on each of which are formed two cam surfaces. One of these, by suitably connecting levers, withdraws the locking wedge which prevents the turret from rotating. The other one acts on the free end of toothed segment *B*, which may be seen in the end view. This segment meshes with a sleeve at *E* on the turret spindle, this sleeve being connected to the spindle by a pawl and ratchet. As the cam *A* forces the segment over, after unlocking the turret, sleeve *E* is revolved and the ratchet carries the turret with it for a third of a revolution. When this movement has been completed the locking wedge is dropped into place and the turret may then be fed up to the work. Arm *B* thereupon again returns to its normal position, the pawl slipping back over the ratchet ready to engage it again the next time it is necessary to index the turret. From the fact that both the indexing and the locking mechanisms are controlled from cam surfaces integral with each other, it is impossible for any one to carelessly set the indexing mechanism to operate before the turret is unlocked or derange the order of operation in any other way. There are three cams *A*, which may be arranged in any position so as to index the turret whenever it is necessary to do so.

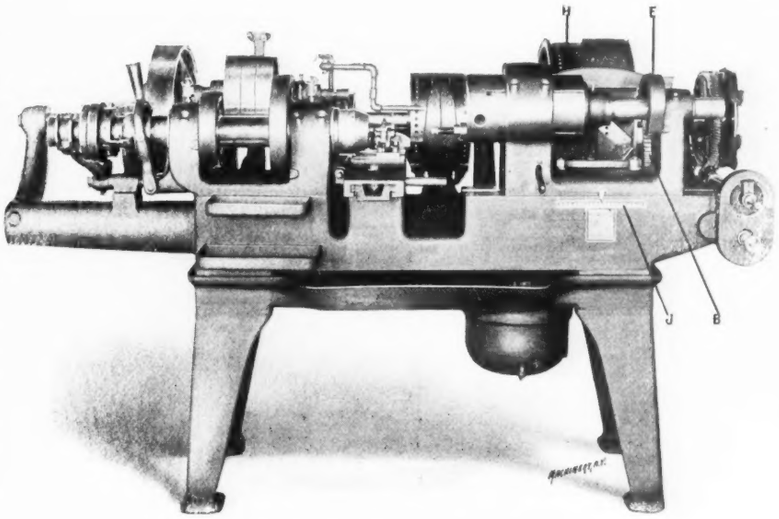


Fig. 1. The Cleveland Three-hole Turret Machine.

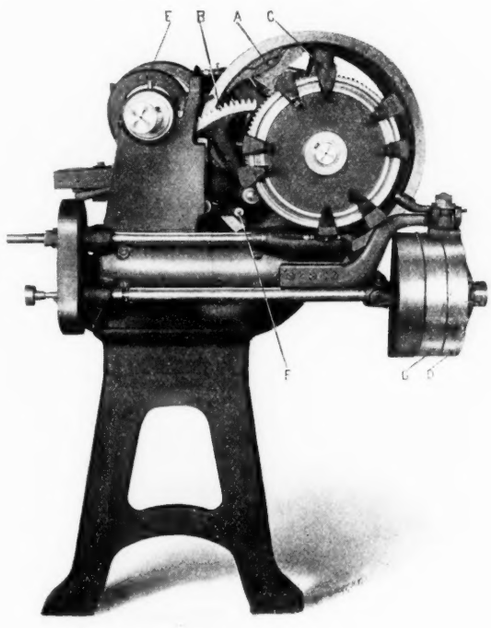


Fig. 2. End View of Three-hole Turret Machine.

On the drum *H* is mounted a series of cams for feeding the turret. Two sets of these cams are provided, these, in conjunction with the fast and slow motion for the cam shaft, being sufficient to cover the usual run of work. The advantage of this fast and slow movement is readily apparent. Full control of the feeding is given with no loss of time. That is to say, the cam may advance the turret the full stroke of seven inches or may advance it a length of only one-half inch, as the case may be. If the latter condition is desired, the turret is fed forward rapidly for the first 6½ inches, when the belt is shifted onto the slow pulley and fed slowly for the remaining half inch. If it is desired to take two strokes of the turret tools, each of them only one-half inch long, the turret may be arranged to recede just far enough to clear the end of the stock without carrying it back the full stroke. The machine is then indexed and the next feeding cam rapidly brought into position for its second half-inch feeding stroke. The turret can also be held in the rear position for all operations, thorough control of the turret being given for either long or short strokes.

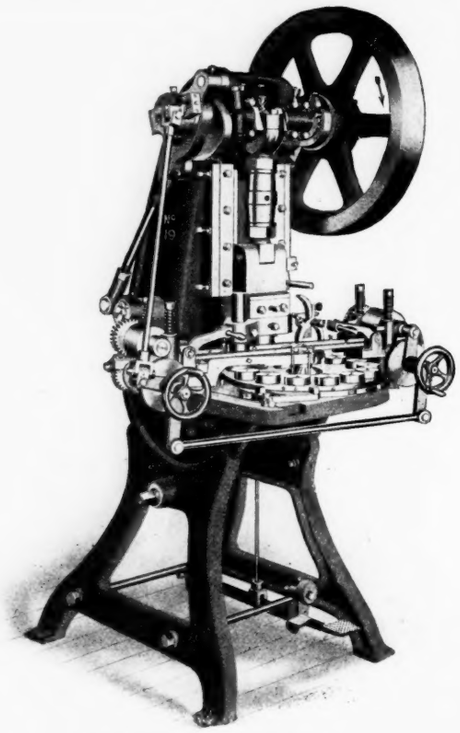
The head may be adjusted forward and back for a distance of nine inches. It not only carries with it the turret, but the drum *H* on the cam shaft as well, and the entire turret-feeding and indexing mechanism. Drum *H*, though splined to the cam shaft, is free for this purpose, to move longitudinally. This adjustment provides means for operating on various lengths of stock. On the front of the machine in Fig. 1 is shown a scale, fastened to the bed, and above it a pointer on the head. The pointer and scale may be used to duplicate the setting of the head for any given piece whenever it is desired to do a job the second time, since if the original setting is noted and a record kept, the machine may again be set to the same identical position. This arrangement materially lessens the time required to set the machine up for doing work which has been done before.

By using bushings to enlarge the diameter of the shanks of the various turret tools, those furnished for the regular machine may be used. Such attachments as magazines, third spindle speed, high-speed drilling mechanism, etc., may be provided. The builders have found that this design fulfills the requirements of a large range of the work that an automatic screw machine is required to do. It is built to handle either 1¼-inch or 1½-inch stock, and will take a cut 7 inches long.

"BLISS" PRESS WITH SPECIAL COMBINATION FEED.

The machine shown in the accompanying half-tone is a regular "Bliss" Inclinable Power Press fitted with a special combination feed consisting of a double roll feed, an automatic dial feed and an automatic pickoff. The roll feed takes the material to be operated upon from the reel, and blanks or forms the first operation of the piece to be produced, dropping same into one of the pockets of the dial as it revolves. The dial feed carries the piece under the second punch where it is further operated upon. In some cases it is possible to have a third and even a fourth die, the dial feed carrying the piece successively under the several punches. The second set of feed rolls is used for keeping proper tension on the stock and also for carrying away the scrap.

As illustrated, the press is fitted to take heavy paper from the rolls and feed it over a cover which has been previously drawn in a combination die. The first punch cuts out a paper disk which is dropped into a recess in the cover—the cover being on the dial which passes under the blanking die. The



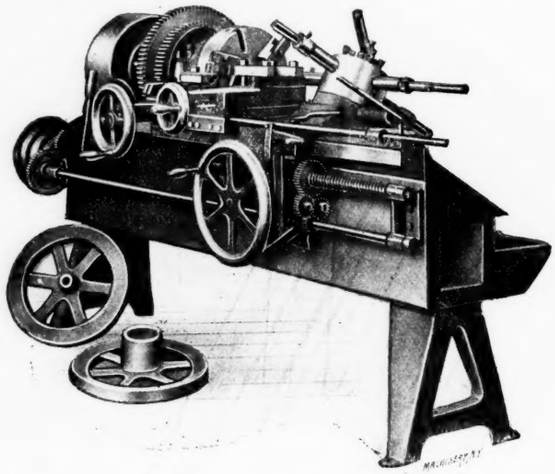
Bliss Press with Special Feed.

second punch closes down the edge of the recess, thus holding the paper tight. The nature of the work is such that it is impossible for the finished article to fall through the pockets of the die, and in order to rapidly remove the work an automatic pickoff is employed. This consists of two fingers which are operated by a small arm on the slide. At every stroke of the press the gripping fingers close about the article and automatically eject it. All that is required for the operator is to keep the pockets of the dial full of the covers. This is done rapidly and without any danger to the operator's fingers, inasmuch as his hands need never be near any of the dies.

The feed is of a type which has a wide range of usefulness, and with modifications may be fitted to almost any type of press. This press was built by the E. W. Bliss Co., 5 Adams Street, Brooklyn, N. Y.

THE MOLINE TOOL COMPANY'S TURRET LATHE.

This machine, of which one form only of a number of alternative arrangements is shown in the accompanying half-tone, has been designed by its builders, the Moline Tool Co., Moline, Ill., for handling castings and bar work. The illustration shows it fitted with tools for machining small gasoline engines or automobile flywheels. The carriage has a turret for boring operations and two cross slides, one of which carries the tools for turning and facing the rim of the flywheel, while the other machines the pulley which in some cases is cast solid with the wheel. This second slide rest has a forming attachment for crowning the pulleys. The feed for this carriage is actuated by a nut which travels on a stationary screw of coarse pitch; the nut is long and the screw may be turned end for end in case one side of the thread gets badly worn, thus making a durable feeding mechanism. The nut is driven from the feed rod through tumbler gears and one lever controls the starting, stopping, and reversing. The bed, as may be seen in



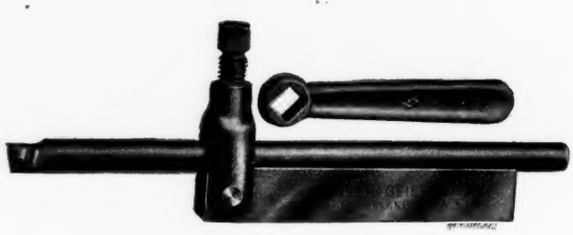
Moline Tool Company's Turret Lathe.

the illustration, is made of hollow box form with its top inclined so that the chips slide off into the pan at the rear. The carriage has a long bearing on the rectangular way at the front and on the surface at the top of the bed. The cross slide is supported at the rear by two flat ways, the upper one extending out below the lower one so that the chips do not fall upon the bearing parts at all.

The spindle is 6 inches in diameter and has through it a 3¾-inch hole. In the arrangement shown, three speeds only are provided, one direct and two back geared, all of them secured by the lever at the right of the headstock. This headstock is cast solid with the bed. The driving pulley is 16 inches in diameter and wide enough for a 6-inch belt, and the lowest back gear ratio is 12 to 1. This head, however, is a special arrangement, the regular design providing for eight changes of speed or, with a double-speed countershaft, sixteen changes arranged in geometrical progression. An alternative arrangement also provides for a change-gear box in place of the cone pulleys shown.

THE GEIER BORING TOOL HOLDER.

This holder is adapted to make use of tools with a cutting lip forged from round unannealed stock. The tool may be extended from the holder just enough to reach the bottom of the hole it is desired to bore, thus giving the cutting edge all the support possible, and at the same time furnishing a con-



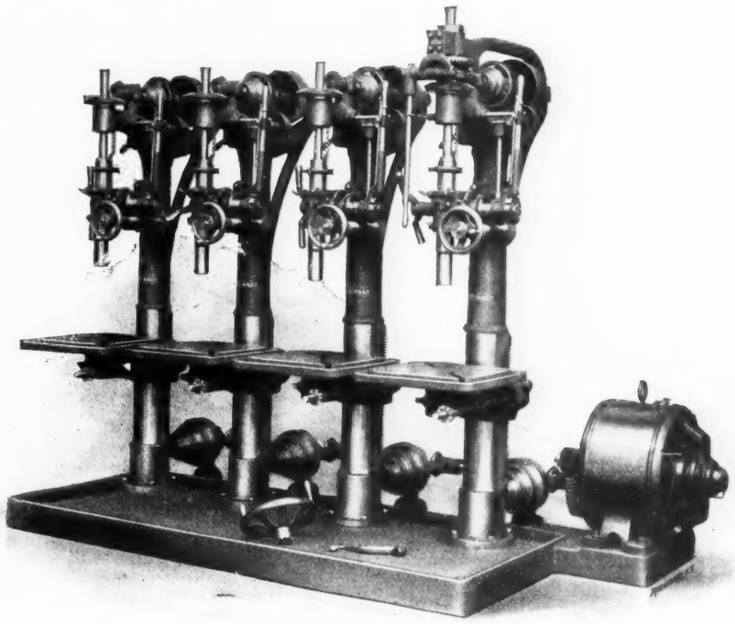
Geier Boring Tool Holder.

venient gage for the depth. The clamping of the holder in the tool post serves also to clamp the tool more firmly in the holder. The shank is milled from bar steel and case-hardened, and will fit any tool post with a 9-16 x 1-inch slot or larger. The yoke is drop forged of steel and has a hardened steel set-screw A drop-forged wrench is packed with each tool. This holder is made by the P. A. Geier Co., Cleveland, Ohio.

CINCINNATI HEAVY PATTERN GANG DRILL.

The cut shown herewith illustrates a special arrangement of 21-inch drills, built by the Cincinnati Machine Tool Co., of Cincinnati, Ohio. As shown, four of their heavy pattern drills of this size are arranged in a row and driven by a constant-speed motor at the right-hand end. The regular tight and loose pulleys on the machines have been discarded and a bevel gear drive substituted in place thereof. The first machine in the row is fitted with a positive-geared tapping attachment, but otherwise the four are alike in design, having wheel and lever feed, back gears, quick return to the spindle and power feed. The raising and lowering device for the tables is necessarily different from the standard form in that it is operated from the front. Square, oil-grooved tables will be furnished in place of the usual round ones unless otherwise ordered, since it is designed to use a pump and suitable piping for conveying a lubricant to the drills, returning it again to a tank for use over again.

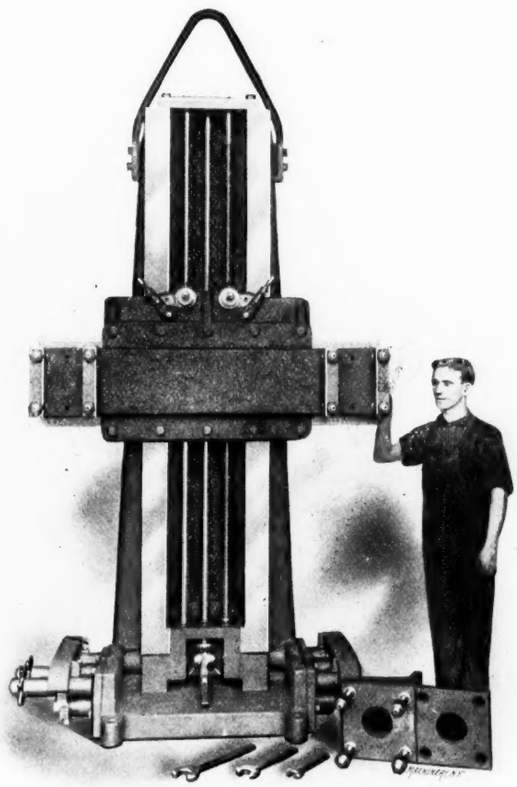
The arrangement shown can be modified to suit any conditions required by the purchaser. The drills may be furnished with or without tapping attachment, with or without back gear, with or without power feed, or with one continuous table instead of square or round tables. Any other form of drive than that shown will also be provided by the makers if so desired.



Cincinnati Motor-driven Gang Drill.

PORTABLE TOOL POST.

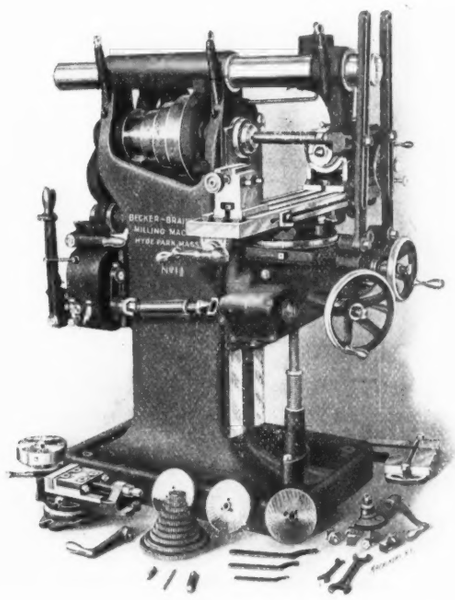
In connection with the Crocker-Wheeler boring mill which was illustrated in the November issue, we mentioned a portable tool post built by the Espen-Lucas Machine Works, Philadelphia, Pa. This tool, in a modified form as shown in the cut, can now be furnished by the builders for a number of uses which will readily suggest themselves. It may be used as a tool post for a boring mill of the type before mentioned, or it can be used as a stationary tool post for working on the outside of castings in the ordinary type of boring mill. In the arrangement shown, the feed for the head and ram is obtained through star wheels at the base. The machine is very strongly built for doing heavy work, steel castings being used throughout to give the required stiffness for the work it is designed to do.



Espen-Lucas Portable Tool Post.

THE BECKER-BRAINARD UNIVERSAL MILLING MACHINE NO. 1 1-2.

The machine shown in the cut has been put on the market to fill a demand for a machine heavily and strongly built, having a capacity midway between the regular No. 1 and No. 2 machines. This size will take a cut 24 inches long, has an 8-inch cross feed, and a 17-inch vertical movement. The spindle is of hammered crucible steel with a ¾-inch hole throughout its length and a No. 10 B. & S. taper in the front end. It is threaded to take a chuck, and slotted across the end to engage the clutch collars on the cutter arbors. The spindle



No. 1 1-2 Becker-Brainard Universal Miller.

is provided with protected back gears. The knee is of the box type, provided with telescopic elevating screw. The elevating and cross-feed hand wheels are provided with a clutch arrangement which allows these wheels to turn freely when not in use, thus preventing an accidental change in the adjustment. Adjustable dials are provided for all the movements graduated to read to .001 inch. The feed change mechanism will give instantly without stopping the machine twenty changes of feed, by a simple movement of the lever.

The machine being full universal, the table is centrally driven and feeds freely at any angle up to 45 degrees right or left hand. The dividing head can be set at any angle from 10 degrees below the horizontal to 5 degrees beyond the perpendicular. The front end of the spindle of the dividing head is identical with the machine spindle so far as its taper and its thread are concerned. A raising block is provided which allows the head to be set at any angle for taper work. The head is arranged for plain and differential indexing for all numbers up to 360. The change gears provided give a range of spiral cutting from 1.25 to 68.57 inches pitch for one turn. The machine is built by the Becker-Brainard Milling Machine Co., Hyde Park, Mass.

LANDIS CRANK GRINDER.

The illustrations in this connection show a crank grinding machine for grinding single and multiple crank shafts for automobile engines, launch engines, etc. The machine has recently been placed on the market by the Landis Tool Company, Waynesboro, Pa., and as now made is fitted with adjustable heads of an entirely new design so that the several crank pins may be accurately and quickly located in their correct relative positions for grinding. The head and foot stocks are geared together, their spindles being driven by a splined shaft upon which slide the pinions which transmit power to the spindles.

Fig. 1. Landis Grinder arranged to Finish Automobile Crankshafts.

The adjustable offset heads for carrying the work when grinding the crankpins hold the cranks by end journals and when in use are attached to the faceplate of the machine. These heads are arranged with two independent rotary adjustments. One of these adjustments is for locating the crankshaft so as to give the correct throw to the cranks and the other consists in an adjustment for the clamp which grasps the work and is for obtaining the different relative crank positions. For example, if the cranks are spaced 120 degrees or 180 degrees apart, the second adjustment would be used to locate the different pins at these angles.

In Fig. 2 is a cross section and a front view of one of the adjustable heads. In the front view, the circle of largest diameter represents the periphery of the face plate, and the slot in the upper part of the plate is for attaching the counterweights. The disk *D* which is mounted eccentrically upon the faceplate and is held to it by bolts in a circular T-slot, may

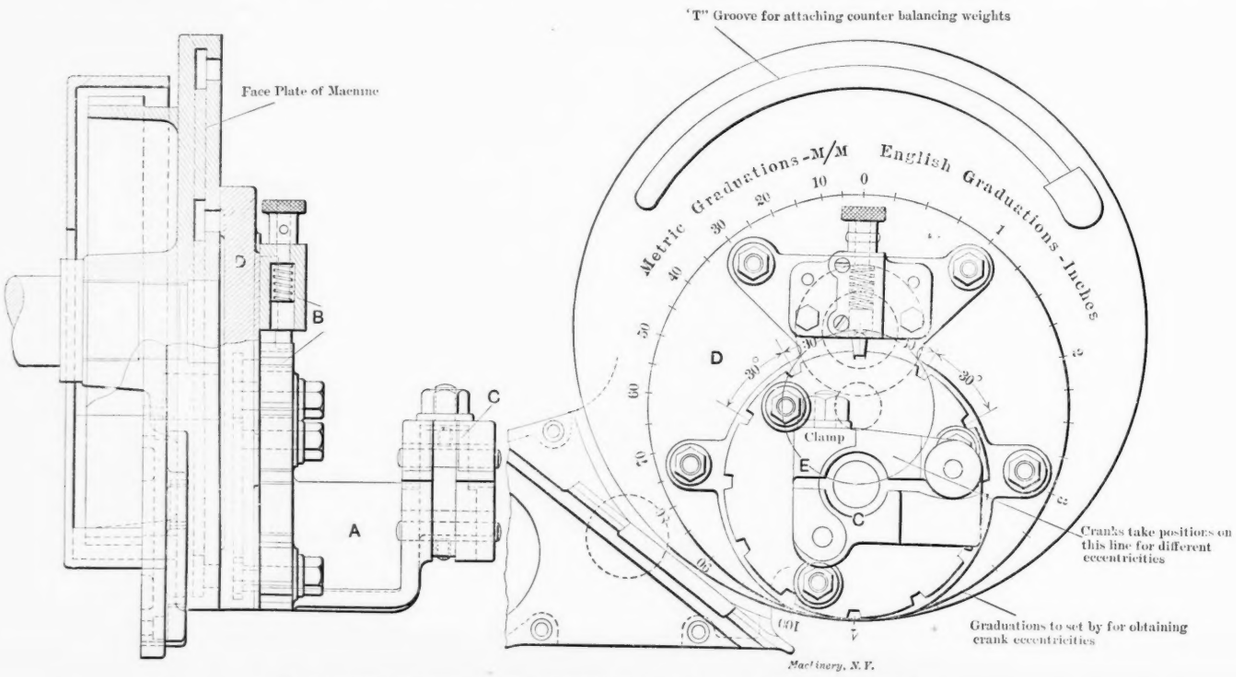


Fig. 2. Special Chuck for Holding Crankshafts having up to four inches Eccentricity.

be swiveled to give the desired throw or eccentricity to the crank. The clamp *C* which grips the work is attached to a smaller disk, *E*, which, with the stop pin used to locate this plate at the proper angle, is carried by a base or spider, bolted to the disk *D*. This smaller disk *E* which carries the clamp, is eccentric with the large disk *D*. Graduations on the periphery

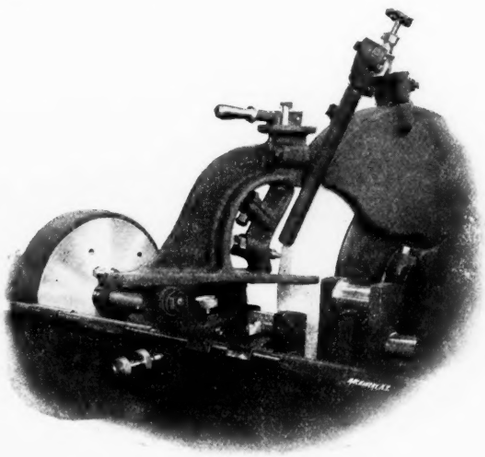


Fig. 3. Wheel Truing Device in Operation.

of the large disk are made both in English and metric units and in swiveling it, the center of the shaft follows the circle *E* until it reaches a point which is the correct radial distance from the center of the faceplate of the grinder, when the disk *D* is clamped, holding it permanently in this position. The other adjustment, by which the small disk *E* and the clamp which it carries is rotated to the proper crank angle, is effected by the stop pin *D* fitting in notches in the edge of the disk.

In Fig. 3 is shown the emery wheel truing fixture in place for use, attached to the top of the stationary back rest. The lever on top is for swiveling the diamond holder when rounding the corners of the wheel for grinding fillets.

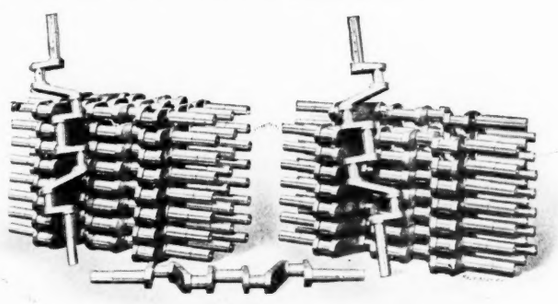


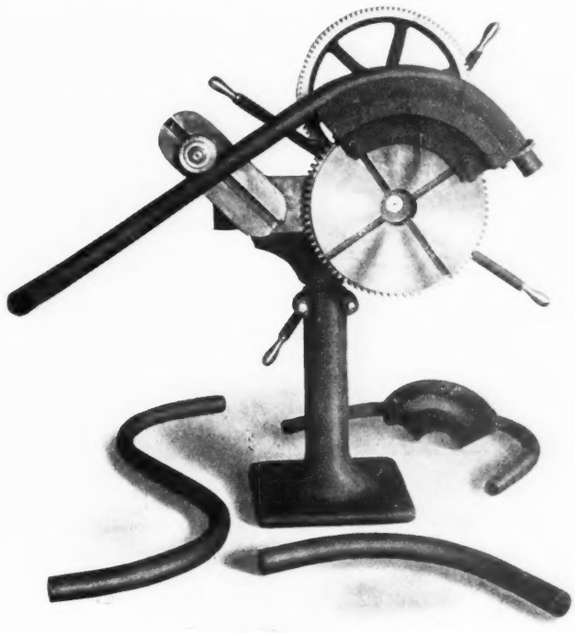
Fig. 4. A Pile of Fifty Finished Crankshafts.

Fig. 4 shows some of the products of the machine, this representing fifty automobile crank shafts. The parts to be ground are the four crank or wrist pins, 1¾ inch diameter by 3½ inches long; three journals 1⅞ inches diameter by 3½, 4½ and 6½ inches long respectively. In grinding 1/32 of an inch was removed from the diameter and the average time for each crank was two hours.

PEDRICK & SMITH PIPE-BENDING MACHINE.

The accompanying half-tone illustrates a machine for bending pipe, which has been recently perfected by Pedrick & Smith, Germantown, Philadelphia, Pa. With a machine of the size shown steel, iron, brass or copper pipe can be bent cold of any size up to and including two inches in diameter. By using special formers, light angles, flats and T-bars may also be handled. The power for the operation is furnished by a handwheel geared at a ratio of 25 to 1 with the faceplate to which the bending quadrants are attached. The pipe is held in the quadrant at one end by means of a steel plate while the resistance stud on the adjustable arm engages the other end. The various curvatures are obtained by adjusting the arm, which has a swing of three-quarters of a circle, supplemented by the movement of the resistance stud in the T-slot of the arm.

By means of the telescopic stand on which it is mounted the machine may be raised or lowered to any suitable height. With the base fastened to the height desired the upper part may be swiveled to any angle. For work that is awkward to handle in a vertical plane, a universal arm for the stand is provided which allows the faceplate to be placed in a horizontal position at any height from the floor. Quadrants are regularly furnished with the machine for 1-inch pipe with a



Pedrick & Smith Pipe-bending Machine.

radius of 6 inches, 1¼-inch pipe with a radius of 9 inches, 1½-inch pipe with a radius of 12 inches, and 2-inch pipe with a radius of 14 inches. While these four quadrants are provided, smaller sizes of pipe can be readily bent in the larger sized quadrants. From practice it has been found that workmen will not take the time to change the quadrant unless they desire a smaller radius than the larger quadrants will give them.

EBERHARDT BROS. SIXTEEN-INCH SHAPER.

The Eberhardt Bros. Machine Co., 66-68 Union St., Newark, N. J., have put on the market a 16-inch crank shaper which possesses a number of novel features. Perhaps the most noticeable innovation, looking at the machine face on, as it appears in Fig. 2, is the shape of the guiding surfaces of the ram. The ram is seated in vertical V-ways similar to the bearings of a planer table. The V-ram has the advantage of guiding the tool in a rectilinear position which tends to wear itself continuously in alignment, with the added advantage of an increased rigidity of ram and frame under severe side strains when taking a heavy cut with a side tool. With the frame of the shaper made as it usually is, open in the center to allow the insertion of shafts for key seating, the tendency is to spread apart the side-bearing surfaces of the ram, allowing a looseness which produces chattering of the tool and reduces the efficiency of the machine. With the construction shown, however, the two sides of the frame are tied together by the ram itself, the heavy strain of a roughing cut with the side tool being taken directly by broad, flat straps, the pressure being normal to these straps. The makers state that this arrangement has shown itself to be of decided value in increasing the capacity of the machine when taking cuts of any kind which tend to give a side pressure to the ram-bearing surface.

Another interesting feature is the fact that the stroke may be adjusted while running, and this adjustment may be made in accordance with graduations visible even when the machine

is running at the highest speed. Instead of the usual plan of having a scale on the moving ram read from a stationary pointer, the scale is mounted on a bracket projected from the boss which supports the bull wheel, as shown in the line drawing, Fig. 3, the pointer being replaced by a continuous circular graduation on a collar which moves in or out on the end of the shaft to correspond with the change in length of the stroke. The position of the ram with relation to the

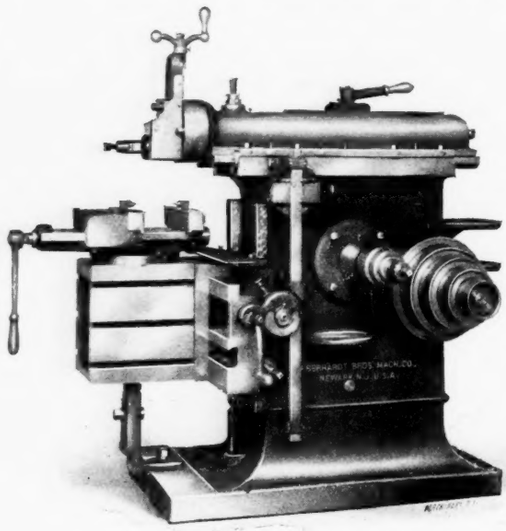


Fig. 1. Eberhardt Bros. Sixteen-inch Shaper.

cross head may also be adjusted when the machine is running, if necessary, by means of a crank on the vertical squared shaft projecting from the top of the ram. The machine is furnished in the single-geared or back-geared design as desired by the purchaser. In the back-geared style a double train of gearing is used with a double bull wheel, as shown by the line cut. This feature, although not new, has not been generally adopted. It costs little more than the usual methods of back gearing, and has the advantage that the cutting power and

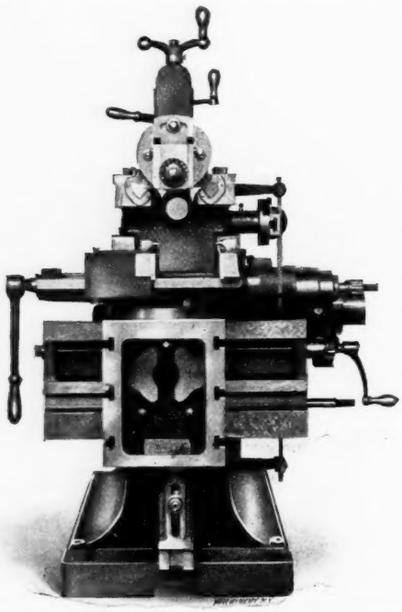


Fig. 2. Front View, showing Design of Ram Bearings.

cutting speeds may be conveniently adjusted to suit various grades of material and classes of work without the high-rotating speeds of shafts and gears which are unavoidable in other designs when running on short strokes. The cone pulley runs on its own bearing and not upon the pinion shaft, thus relieving the shaft of all belt strain.

The box table is of the universal type and may be swiveled in a circle; any side of the box may thus be used as a working side. The vise is graduated and may also be swiveled to any angle. The construction is such that the jaws are drawn together instead of being pushed, thus subjecting the screw to a compressive instead of a tensile strain. This has the advantage of holding the work more firmly without straining the body of the vise. The method of holding the vise to the table is such that all adjustments are made from the top. The feed is operated by the vertical reciprocating feed bar shown in Fig. 1. The connection with the cross-rail mechanism is through a friction strong enough to carry the heaviest feeds, yet light enough to offer little resistance to raising or lowering the table whenever necessary. The feed may be changed instantly when the machine is running or at rest. There are no rapidly oscillating or revolving parts to be adjusted, and the hand wheel used in the adjustment is so located that danger of injuring the fingers of the operator is avoided. The table is furnished with extension base and positive support, this support being conveniently adjustable. The foot is reversible to allow the support to be used when the table is raised or

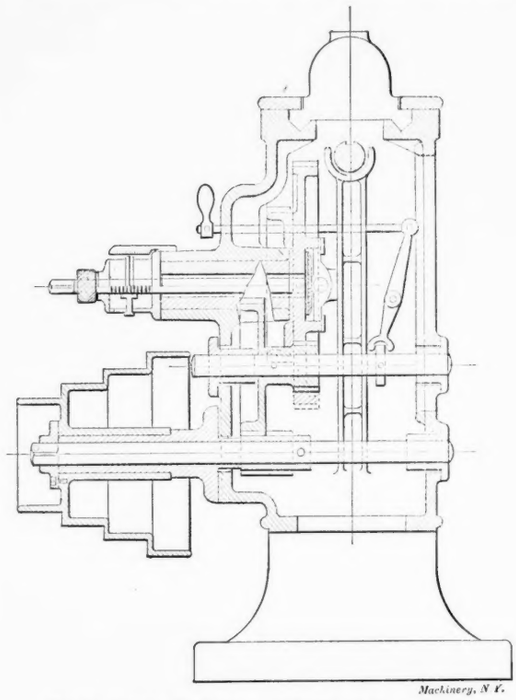


Fig. 3. Driving Mechanism of Eberhardt Bros. Shaper.

in the lowest position. The general design of the machine is intended to fit it for taking the heaviest cuts required for manufacturing, and at the same time give it the accuracy required for tool room work, with all the adjustments so arranged that they may be altered without loss of time while the machine is running. If desired, this shaper will be furnished without the back gears.

AUTOMATIC ROTARY SURFACE GRINDER.

The half-tone cut shows a surface or face-grinding machine of the vertical spindle type. The spindle of the machine is driven by a cone of pulleys with eight diameters giving spindle speeds suitable for any work within the range of the machine. A magnetic chuck is regularly furnished for holding the work, this affording the quickest way of fastening thin parts without the liability of springing them. A direct current of either 110 or 220 volts will operate this chuck satisfactorily, connection being made with an ordinary lamp socket. Alternating current cannot be used. In shops where direct current is not available the makers furnish a small generator which can be driven from the line shaft and placed in convenient location. The chuck takes about the same amount of current as a sixteen-candle-power light. If for any reason the magnetic chuck is not wanted a special quick-acting chuck will be furnished. It has three external jaws operated by a single lever and one internal jaw which grasps the inside of the ring or other work being done, hold-

ing it from turning in such a way as not to distort it. For varying the depth of the feed the whole spindle mechanism and chuck is raised by an annular graduated hand wheel shown at the front of the machine. The spindle runs in adjustable bushings which may be taken up as the bearings wear.

The emery wheel is mounted in a crosshead at the top and is provided with a fast feed for roughing and a slow feed for finishing. The action of the feed is such that the wheel is moved in and out between the center and the circumference of the work that is being ground. The crosshead can be adjusted to grind the work either thicker or thinner at the center than at the circumference. The feed may be either automatic or by hand, as desired. An exhaust fan removes all dust, adding to the life of the machine and the comfort of the operator.

Goddard Rotary Surface Grinder.

The builders, the Goddard Machine Company, Holyoke, Mass., especially recommend the machine for grinding and fitting piston rings. This work can be handled in such a way as to meet the most exacting requirements at a small fraction of the cost of filing and scraping. The design is simple enough to allow the machine to be used by boys or unskilled labor. The makers will furnish the machine with a motor drive when so desired by the customer.

PIPE THREADING MACHINE.

The Merrell Manufacturing Co., Toledo, Ohio, is making a power pipe threading machine in two sizes, No. 8 and No. 12, having a combined range for pipe from 1 to 8 inches in diameter. Some of the features of this design are: the location of the cone directly above the spindle and the inclosing of the back gears within the cone where both they and the workman are protected; a quick opening and closing die head which may be operated while the machine is running; and an improved vise and feeding arrangement. The vise is self centering and feeds the pipe into the chasers by a friction lead screw connecting the vise frame to the die head, through a cam which closes the lead nut on the screw. The pipe can, however, if desired, be fed into the chasers by a hand wheel. In the continuous operation of this machine, on a given diameter of pipe the work may be cut to length and threaded continuously without throwing off the power.

THE MUELLER RADIAL DRILL PRESS FEED.

The Mueller Machine Tool Co., Cincinnati, Ohio, has designed a new feeding mechanism which they are applying to their line of radial drills. It is the belief of the builders that, while positive feeds are necessary in using drills and reamers made of high speed steels, yet there are some classes of work in which it is detrimental. In the arrangement shown in Fig. 1 either a positive or a friction feed may be used at the will of the operator. The spindle carries on the driving gear at its upper end a disk whose upper surface carries seven circles of steel pins. These pins engage with a steel pinion, with teeth of involute form, on the horizontal worm shaft, which drives the vertical feed shaft with the handwheel at its lower end. Extending through a hole in the center of this shaft is a rod having a knurled knob at its lower end and a small pinion at its upper extremity. The pinion meshes with rack teeth cut in a horizontal rod and by

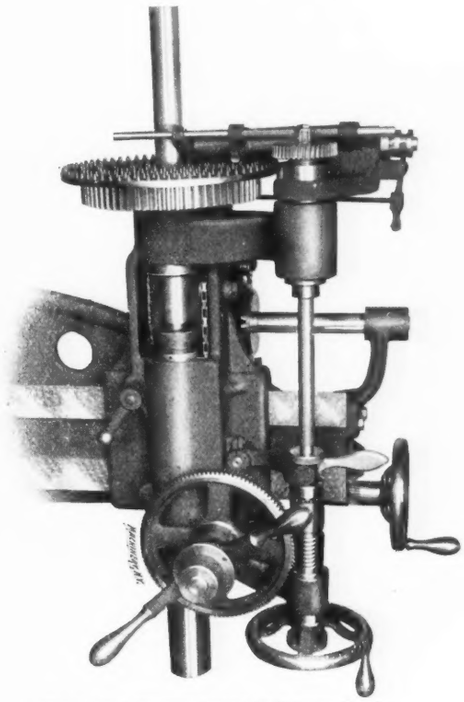


Fig. 1. The Mueller Radial Drill Press Feed.

this means the operator may shift the sliding gear to engage with any one of the seven circles of pins in the feed disk, thus giving seven changes of feed. The mechanism allows change to be made while the drill is at work. The upper worm wheel has its hub split and by means of a ring nut it

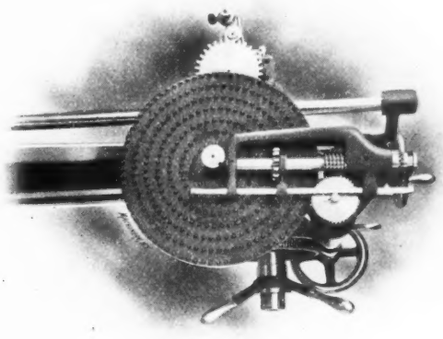


Fig. 2. Top View of Feed Change Mechanism.

can be locked to the vertical feed shaft if a friction feed is required. The automatic feed is tripped by disengaging a clutch shown on the end of the horizontal feed shaft.

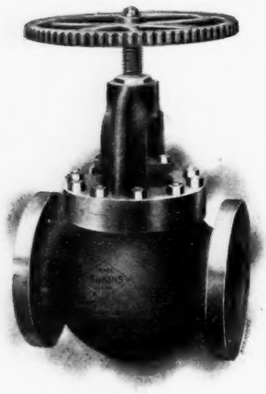
Fig. 2 is a view looking down on the top of the mechanism and shows quite plainly the means provided for varying the rate of feed.

THE JENKINS LINE OF EXTRA HEAVY VALVES.

Some time ago Jenkins Bros., of 71 John St., New York, placed on the market a line of extra heavy brass valves suitable for working pressure up to 300 pounds. This line proved very popular with their customers and a demand arose for a similar line of iron body valves. While heavy iron body valves had previously been built, they had all been built to meet special conditions, and consequently there was no standard design, the different sizes varying widely in their general

dimensions. The design of a standard line has now been completed, and every question which the manufacturers' experience in the making of valves could suggest has been thoroughly discussed.

These valves are made in sizes from 2½ to 12 inches inclusive, either screwed or flanged, and either globe or angle body style. They are guaranteed for a working steam pressure of 250 pounds, each valve being carefully tested before leaving the factory with 800 pounds hydraulic pressure. The materials used and the proportions of the different parts are such that the valves are expected to resist not only the stresses due to pressure, but also those due to the expansion and contraction of the piping, and other accidental strains. In the sizes 5 to 12 inches, inclusive, the valves will be supplied, if desired, with a by-pass cast integrally with the body. The by-pass on the 12-inch valve is fitted with an iron yoke bolted; below 12 inches the by-passes are fitted with brass bonnets which are screwed into the body. All the flange valves are fitted with manufacturers' standard extra heavy flanges, and the drilling, when ordered, will be in accordance with this standard unless otherwise specified. The makers advise the use of flange valves for sizes 7 inches and over.



Jenkins Extra Heavy Valve.

TUCKER SIGHT FEED LUBRICATORS.

W. M. & C. F. Tucker, of Hartford, Conn., make the two new styles of oil cups shown in the cuts below. In style *A* the body is of glass so that the supply of oil will be always visible; in style *B* the base of the cup is formed into a protective sleeve with openings to allow the oil level to be seen. The cap is fitted with two ports which serve the double purpose of making it easy to fill in any position and allowing the escape of air as well. The feeding is done by capillary attraction. The cup is arranged with a positive stop, and when turned in either direction against the stop the ports are closed and dust proof. This lubricator is especially adapted for small bearings running at high speeds and needing constant lubrication.

Fig. 1. Glass Body Lubricator.

Fig. 2. Protected Lubricator.

A COMBINATION HORIZONTAL AND VERTICAL DRILLING AND BORING MACHINE.

This tool has been recently built by the Hoefer Mfg. Co., of Freeport, Ill. Its purpose is the drilling and boring of holes in large castings simultaneously, when such holes are required to be at right angles to each other. It consists of a bed plate with a lower extension carrying a horizontal boring and milling machine of the usual type, and a rearward extension which forms a support for a radial drill. By this means, without moving the work, any point on the top or end surfaces of a heavy casting may be reached. Each spindle is driven with a separate belt from the line shaft so that they may be operating independently of each other.

EXAMPLES OF ELECTRIC WELDING.

The accompanying illustrations show some of the recent interesting work in electric welding done by the Standard Welding Co., Cleveland, Ohio. Fig. 1 is a spool or circular band of special shape made of cold rolled steel, the outside diameter of which is 13⅞ inches, and it is 7 inches long. It is bent in the form of a circle and welded electrically, after which it is shaped by a special process. This band is used for winding the fibers of cellulose in the manufacture of artificial silk, and indicates the wide range of devices and machine parts that electrical welding is adapted for.

Fig. 1.

The second illustration shows a cylindrical body made from seamless drawn tubing with a cap electrically welded on one end and a band on the other, making an extra thickness of wall for threading on the inside of the open end. This is manufactured for the United States government for oil cans used with field limbers. The length of the complete tube is 21 inches and its outside diameter is something over 3 inches.

Fig. 2.

THE ELLIS COMBINATION WRENCH.

The illustration shown herewith is a view of a new adjustable S wrench. As shown in the figure, it may be used as an ordinary straight wrench, adjustable for various sizes of square or hexagon nuts and screws. It will be seen, however, that the handle is adjustable to a position on either side of the center line, making it a right-hand offset or left-hand offset adjustable wrench. This allows the tool to be used in cramped quarters where the use of other wrenches is out of the question. If desired, the upper straight jaw may be removed and a pipe jaw inserted. This makes a handy pipe wrench which will work around corners, behind pipes, and in other inaccessible places. The change from nut wrench to pipe wrench can be quickly made. It is especially recommended for use on automobiles by the selling agents, Patterson, Gottfried & Hunter, Ltd., 146-150 Center St., New York City.

The Ellis Wrench.

* * *

The Pennsylvania Railroad Co. is electrifying part of the Long Island Railroad system and has recently made a contract with the General Electric Co. for the complete electrification of one of its lines running between Philadelphia and Atlantic City. The entire steam equipment of this road will be discarded, it being the intention to run all the trains with electric motors. About sixty miles will be electrified at an expenditure of something between $2,000,000 and $3,000,000.